VOLUME 27 • NUMBER 2

May 1956

the RESEARCH Quarterly

STEVENS RICE
UNIVERSITY MICROFILMS
313 N FIRST ST
ANN ARBOR MICH
HPR DEC P ADV

Published by THE A[illegible] ASSOCIATION FOR
HEALTH, PHYSICAL [illegible] AND RECREATION
1201 SIXTEENTH ST[illegible] WASHINGTON 6, D. C.

RECENT AAHPER PUBLICATIONS

Fitness for Secondary School Youth

A joint publication of AAHPER and the National Association of School Administrators. This book contains the most up-to-date information and program outlines for total fitness of our teen-age population. Physical, mental, and emotional fitness are considered in relation to health, physical education, recreation, and outdoor education. 1956. 150 pp. $2.50

Framework for Family Life Education

This book reports on a nation-wide survey of family life education in the schools and outlines programs and courses. 1956. 117 pp. $2.00

The First Three Pamphlets of a New Series in Health, Physical Education, and Recreation for the Classroom Teacher Prepared by a Joint Committee of the AAHPER and the Classroom Teachers (NEA).

1) *Teaching Dental Health to Elementary School Children* 1956. 32 pp. 75¢

2) *Classroom Activities.* 1956. 64 pp. $1.00

3) *Outdoor Education.* 1956. 32 pp. 75¢

Teachers Guide for Physical Education for High School Students

Shows how to use *Physical Education for High School Students* for more effective teaching of physical education. 1955. 60 pp. 50¢

Order From

AAHPER, 1201 16th St., N. W., Washington 6, D. C.

the RESEARCH Quarterly

of the American Association for Health, Physical Education, and Recreation, Department of the National Education Association, 1201 Sixteenth St., N.W., Washington 6, D. C.

Vol. 27, No. 2 MAY 1956

CONTENTS

Unilateral Activity and Bone and Muscle Development in the Forearm — Elsworth R. Buskirk, K. Lange Andersen, and Josef Brozek 127

Study of Four Programs of Heavy Resistance Exercises for Development of Muscular Strength — Edward K. Capen 132

Effect of Preliminary Passive Warming on Swimming Performance — Forbes Carlile 143

Proposed Method of Analyzing Sociometric Data — Patricia Whitaker Hale 152

Age Differences and Inter-relationships Between Skill and Learning in Gross Motor Performance of Ten- and Fifteen-Year-Old Boys — Franklin M. Henry and Gaylord A. Nelson 162

Evaluation of Motor Learning When Performance Levels Are Heterogeneous — Franklin M. Henry 176

Influence of Puberal Development on Responses to Motivated Exercise — Birger L. Johnson 182

Comparative Analysis of Items of Interest in Marriage and Parenthood of 4,000 Students in Junior and Senior Colleges — Joseph E. Lantagne 194

Cross Transfer Effects of Training on Strength and Endurance — Donald K. Mathews, Clayton T. Shay, Frank Godin, and Robert Hogdon 206

A Factor Analysis of Tests of Endurance — C. H. McCloy 213

Comparative Effects of Rest, Exercise, and Cold Spray Upon Performance in Spot Running — Frank D. Sills and Vernon E. O'Riley 217

Relation of Certain Physical Traits and Abilities to Motor Learning in Elementary School Children — Jean A. Smith 220

Relationship of Occupancy and Adequacy of Student Housing to Incidence of Acute Upper Respiratory Conditions — Wesley M. Staton 229

Comparison of Two Methods of Teaching Beginning Basketball — Peggy P. Whilden 235

NOTES AND COMMENTS—Evaluation of Physical Education in North Carolina High Schools, Nathan Taylor Dodson, 243; Observations Regarding Elvera Skubic's Study, "Emotional Responses of Boys to Little League and Middle League Competitive Baseball," Research Quarterly, 26: 342-352 (Oct. 1955), Warren R. Johnson, 245.

Research Abstracts 246

Copyright, 1956, by the American Association for Health, Physical Education and Recreation, National Education Association

Carl A. Troester, Jr., Executive Secretary

Assistant Secretaries

Elizabeth Avery, Consultant in Health Education

Rachel E. Bryant, Consultant in Physical Education and Girls and Women's Sports

Jackson M. Anderson, Consultant in Recreation and Outdoor Education

Eugene H. Sloane, Director of Publications and Public Relations

●

Ella H. Wright, Editor

Jeanette K. Cokouros, Assistant to the Editor

Jean W. Sloan, Circulation Manager

George F. Anderson, Associate Executive Secretary in charge of Advertising

Ames A. Castle, Sports and Industrial Relations Executive

●

Board of Associate Editors

Karl Bookwalter
Marion R. Broer
H. Harrison Clarke
Thomas K. Cureton, Jr.
Anna Espenschade
Franklin M. Henry
Pauline Hodgson
James H. Humphrey
Paul Hunsicker
Leslie W. Irwin
Warren R. Johnson
H. F. Kilander
Joy W. Kistler
Hyman Krakower
Lynn W. McCraw
Kenneth D. Miller
Henry J. Montoye
Laurence E. Morehouse
Marjorie Phillips
Laurence Rarick
M. Gladys Scott
John H. Shaw
Frank D. Sills
Wesley M. Staton
D. B. Van Dalen
C. Etta Walters
Allen E. Weatherford

Published in March, May, October, and December by the American Association for Health, Physical Education, and Recreation, 1201 Sixteenth Street, N.W., Washington 6, D. C. Subscription available to libraries, institutions, and departments at $5.00 per year. Of the Professional Membership ($10.00 per year), $3.00 covers subscription to the *Quarterly*. Of the Student Professional Membership ($5.00 per year), $1.50 is for subscription to the *Quarterly*. *Subscriptions to individuals through membership only.* Single copies $1.25.

Send membership dues or subscriptions to Circulation Dept., 1201 Sixteenth Street, N.W., Washington 6, D. C. Editorial Office, 1201 Sixteenth Street, N.W., Washington 6, D. C. Entered as second-class matter at the Post Office at Washington, D. C., under the act of March 3, 1879. Additional entry at Baltimore, Md.

Manuscripts are to be sent to the Editorial Office and are expected to follow the form prescribed in the Guide to Authors that appears each year in the October issue of the Research Quarterly.

Unilateral Activity and Bone and Muscle Development in the Forearm

ELSWORTH R. BUSKIRK,[1] K. LANGE ANDERSEN,[2] and JOSEF BROZEK
Laboratory of Physiological Hygiene, University of Minnesota
Minneapolis, Minnesota

Abstract

Comparisons of external anthropometric and roentgenogram measurements between the arms of tennis players and soldiers revealed that tennis playing leads to muscular hypertrophy and to an increase in length of the radius and ulna in the forearm used to swing the tennis racket. These findings are discussed in relation to changes in body composition with exercise.

KNOWLEDGE IS limited concerning the change in human body composition with a change in exercise regimen. Although atrophy of bone and muscle is known to accompany prolonged inactivity (1, 2, 6) and muscle hypertrophy to accompany extensive activity (5, 10), little is known about changes in bone or changes in the relationships between bone and muscle with extensive activity. Tennis players exercise one arm almost exclusively and mere inspection shows that they develop one arm more than the other. A comparison was made of the arms of tennis players to evaluate alterations in muscular development and bony structure associated with extensive unilateral activity. In order to assess whether differences between arms of tennis players were larger than for normal young males (non-tennis players), a group of soldiers was also studied.

Procedure

Seven nationally ranked tennis players from the Minnesota-Wisconsin-Iowa area and 11 soldiers from Fort Lee, Virginia, were used as test subjects (Table 1). Each subject spent one afternoon in the laboratory to complete a series of tests and measurements.

Results

An initial comparison of changes in X-ray measurement differences between arms with slight changes in forearm placement and rotation over the X-ray film showed that checks within 1 mm. could be made if all films were rejected

---

[1]*Present address*—Stress Physiology Branch, Quartermaster Research and Development Command, Natick, Massachusetts.

[2]*Present address*—University Institute for Respiratory Physiology, Oslo, Norway.

TABLE 1

Characteristics of Test Subjects

Characteristic	Tennis Players n = 7		Soldiers n = 11	
	Mean	Range	Mean	Range
Age	24.7	21-35	20.8	19-22
Height	180.6	171.7-184.2	172.6	168.0-180.3
Weight	77.3	61.6-88.9	75.9	63.9-88.5

where the styloid processes on the ulnae were not in the same position for both arms. An appreciable error is avoided if this check is made.

The differences found between the arms of tennis players and between the arms of soldiers are shown in Table 2. Hand area, third-finger length, wrist width and the forearm circumference measurements differed between the arms of the tennis players but not between the arms of the soldiers. Tennis players proved to be relatively stronger with their dominant hand than did soldiers.

All of the tennis players had played tennis regularly winter and summer for at least the last seven years. None of the soldiers had engaged in any type of extensive unilateral activity.

Roentgenograms were taken of the supinated hands and forearms including the elbow joint. This was accomplished by having the subject place his elbows about one inch and his hands about half an inch apart on the X-ray film while sitting quietly. Exposure was 10 milliampere seconds with 55 kilovolts peak at a distance of 72 inches. Measurements were made on the developed X-ray film with a rule graduated in millimeters.

External anthropometric measurements were taken of both hands and forearms with a modified Vernier caliper, an anthropometer, and a metal tape. Circumferences were measured at the point of maximal circumference. Grip strength was measured with the standard grip-strength dynamometer. Hand area was obtained from planimetric measurement of a tracing made by having the subject place his hand flat (fingers together, palm down) on a sheet of paper and drawing the outline with a tracing stylus. A paired t-test was used to detect a difference between arms and a two-sample t-test was used to detect a difference between groups (11).

Ulna length proved to be significantly different in both groups, but a slightly more significant difference was noted between arms of tennis players than soldiers. Radius length differed only in tennis players. No differences were observed in thickness of bone cortex, diameter of medullary cavity, or in the diameter of the distal or proximal heads of the radius or the ulna.

Muscle diameter measured on the roentgenograms at mid-ulna was significantly different between the arms of both groups, but the difference between the arms of tennis players was more highly significant. Thus, the difference between arms of the computed ratio of muscle diameter to radius-ulna diameter measured at mid-ulna was significantly larger for the tennis players.

TABLE 2

Comparison of the Dominant Arm to the Other Arm of Tennis Players (T) and of Soldiers (S) as Well as a Comparison of the Difference Between Arms in the Two Groups.

All measurements are in centimeters except hand area and grip strength which are in planimeter units ($\times .10^1$ square inches) and in pounds respectively. (D—dominant arm, Δ—difference between arms, P—Probability level)

Measurement	Tennis Players (T) n = 7						Soldiers (S) n = 11						$\Delta_T - \Delta_S$	
	M_D	σ_D	M_O	σ_O	t_T	P_T	M_D	σ_D	M_O	σ_O	t_S	P_S	t_Δ	P_Δ
1. *Anthropometric, External*														
Hand Area	2.29	0.10	2.25	0.09	2.27	—	2.49	0.15	2.46	0.13	1.54	—	0.05	—
Hand Width	8.54	0.53	8.30	0.44	3.55	.01	8.28	0.34	8.16	0.36	2.25	.05	1.01	—
Third-Finger Length	11.54	0.30	11.38	0.29	3.26	.01	11.62	0.99	11.48	0.98	1.71	—	0.16	—
Wrist Width	5.96	0.23	5.75	0.22	3.66	.01	5.87	0.21	5.68	0.16	2.48	.05	0.19	—
Elbow Width	7.21	0.28	7.09	0.25	1.72	—	7.00	0.25	6.84	0.21	1.38	—	0.25	—
Radial Circumference (relaxed)	28.80	1.79	26.50	1.58	8.93	.001	28.00	1.87	27.20	1.42	3.12	.01	3.06	.001
Radial Circumference (contracted)	29.80	1.87	27.30	1.68	10.64	.001	29.10	1.82	28.10	1.49	3.20	.01	3.01	.001
2. *Anthropometric, X-ray*														
Humerus, Epicondylar Width	6.69	0.40	6.59	0.33	2.17	—	6.46	0.40	6.41	0.40	1.42	—	0.63	—
Radius, Distal Width	3.70	0.16	3.62	0.11	2.30	—	3.61	0.13	3.59	0.10	1.17	—	1.20	—
Ulna, Distal Width	1.86	0.07	1.79	0.07	3.34	.01	1.65	0.17	1.62	0.16	1.94	—	1.24	—
Ulna, Length	25.20	0.78	24.80	0.70	3.44	.01	24.30	1.15	24.10	1.21	2.23	.05	1.75	.05
Radius, Length	26.80	0.84	26.30	0.93	3.75	.01	25.60	1.31	25.50	1.29	1.54	—	2.04	.05
Ulna, Width at Midshaft	1.34	0.12	1.30	0.15	1.70	—	1.33	0.07	1.31	0.07	1.17	—	0.48	—
Radius, Width at Midshaft	1.71	0.12	1.67	0.10	2.50	.05	1.62	0.10	1.57	0.13	1.80	—	0.30	—
Mid-forearm diameter	8.41	0.55	7.94	0.56	5.33	.001	8.00	0.71	7.84	0.78	3.13	.01	2.13	.01
Medial, skin plus fat at mid-forearm	0.33	0.13	0.39	0.11	2.27	—	0.41	0.12	0.47	0.15	3.15	.01	0.53	—
Lateral, skin plus fat at mid-forearm	0.38	0.18	0.41	0.15	1.51	—	0.34	0.10	0.35	0.08	0.76	—	0.11	—
Muscle diameter at mid-forearm	7.70	0.47	7.13	0.50	6.22	.001	7.25	0.58	7.01	0.61	2.95	.01	2.44	.01
3. *Strength*														
Grip Strength	118.60	11.60	105.20	8.60	7.68	.001	113.20	16.98	106.00	17.96	2.66	.01	2.19	.05

Discussion

Although tennis playing has been cited as a unilateral activity, this statement should be qualified. Contralateral arm movement is necessary to elevate the ball for the service as well as to steady the racket prior to hitting the ball during the volley and when hitting ground strokes. Cross-education also occurs (7). These factors would tend to minimize differences in development between the dominant and other arm. The individual who wields a racket with both hands simultaneously or hits a forehand shot with either hand could not, of course, be included in a study of this type.

The results from both external anthropometric and roentgenological measurements showed rather conclusively that large differences existed between forearm musculature of the tennis players. It was of interest to note that the dominant forearm circumference (radial) of one tennis player was larger than his upper arm circumference (brachial). These differences were not as pronounced between the arms of soldiers although a similar pattern was apparent. Bony lengths were increased in the dominant forearm of tennis players, indicating an alteration in the osseous "growth apparatus" (9). No alteration in thickness due to apposition of periosteal bone could be detected. All of the tennis players played extensively in their teens. It is at this time that alterations in growth pattern associated with tennis playing probably occurred (adolescent period). Whether similar differences would be found in men who started playing in their 20's or 30's remains to be seen. It is generally conceded, however, that changes in bone length cease at maturity (9).

Because of the changes in muscle size, in bone length, and in the muscle to bone ratio with this extensive unilateral activity, it seems important that an effort be made to clarify the role of activity in modifying gross body composition.

Some progress in this area has been made. A comparison of two groups of middle-aged men who exhibited long-standing differences in the habitual amount of physical exercise ("active" and "inactive") revealed that the "inactive" men were fatter and less muscular. This comparison was made on the basis of differences in skinfolds, in the excess of chest over abdominal circumference, and in body density. The "active" men were heavier and appeared "overweight"; however, the large fat-free weight of this group indicated a minimal loss of muscular tissues characteristic of the "'normal" process of aging in relatively inactive persons. No attempt was made to assess differences in bony structure in this study (3).

It appears that body composition can be changed with habitual moderate and/or strenuous activity but the data are too few at the present time to modify the existing equations for predicting body fat from body density in the physically "active" man (8). The amount of total body fat in certain types of athletes, namely wrestlers and gymnasts, is underestimated (4).

Unfortunately, it was impossible to make a comparison of bone cortex density between the arms of either group. An additional study is planned tc include this measure and to enlarge the present series of observations.

Summary

External anthropometric and roentgenogram measurements were made of the hands and forearms of seven nationally ranked tennis players and 11 soldiers. Hand area, hand width, third-finger length, wrist width, and forearm circumference (relaxed and contracted) differed significantly between the dominant and other arm of tennis players, but only hand width, wrist width and forearm circumference (contracted) differed between arms of soldiers. Radius and ulna length and distal ulna width were different between the arms of tennis players but only ulna length differed between arms of soldiers. Muscle diameter measured at mid-ulna and grip strength differed between arms in both groups but the differences were larger in tennis players. The ratio of muscle diameter to bone diameter at mid-ulna was larger between the arms of tennis players. Thus, considerable forearm muscular hypertrophy and small changes in radius and ulna length could be associated with participation in this vigorous unilateral activity.

REFERENCES

1. Abrahamson, A. S. Atrophy of disuse. *Arch. Phy. Med.*, **29**: 562-570, 1948.
2. Asher, R. A. J. The dangers of going to bed. *British Med. J.*, **2**: 967, 1947.
3. Brozek, J. Physical activity and body composition. *Arh. Hig. Rada. (Zagreb)*, **5**: 193-212, 1954.
4. Buskirk, E. R., and H. L. Taylor. Relationships in man between the maximal oxygen intake and components of body composition. *To be published.*
5. DeLorme, T. L. Restoration of muscle power by heavy-resistance exercises. *J. Bone and Joint Surg.*, **27**: 645, 1945.
6. Gallagher, J. R., and T. L. DeLorme. The use of the technique of progressive resistance exercise in adolescence. *J. Bone and Joint Surg.*, **31(A)**: 847, 1949.
7. Hellebrandt, F. A., A. M. Parrish, and S. J. Houtz. Cross Education. The influence of unilateral exercise on the contralateral limb. *Arch. Phys. Med.*, **28**: 76, 1947.
8. Keys, A., and J. Brozek. Body fat in adult man. *Physiol. Rev.*, **33**: 245, 1953.
9. McLean, F. C., and M. R. Urist. *Bone.* Chicago: University of Chicago Press, 1955.
10. McMorris, R. O., and E. C. Elkins. A study of production and evaluation of muscular hypertrophy. *Archives of Physical Medicine and Rehabilitation*, **35**: 420, 1954.
11. Walker, H. M. and J. Lev. *Statistical Inference.* New York: Henry Holt and Co., 1953.

(Submitted 10/31/55)

Study of Four Programs of Heavy Resistance Exercises for Development of Muscular Strength

EDWARD K. CAPEN[1]
University of Tennessee
Knoxville, Tennessee

Abstract

This study was concerned with determining which of four methods of weight training might be superior so far as strength development was concerned. Eight groups of university freshmen were utilized in the study and the statistical significance of the differences in the amount of strength that was gained was determined by the use of t-formulas. The results of this research suggests that those methods which employ heavy weights so as to allow a maximum number of five executions are probably the superior methods for the development of muscular strength.

FOR MANY YEARS it has been recognized that one form or another of heavy resistance exercise provided one of the most effective methods for the development of strength. Hellebrandt states that:

> It is an established physiological fact that strength can be augmented significantly only by contracting against a degree of resistance that calls forth maximal effort. . . . This is characterized by repetitive short bouts of exercise, each one of which approaches maximal effort in severity. (6)

In recent years one form of heavy resistance exercise, that of weight training,[2] has come to the front as one of the best methods of exercise for the development of strength. This method has been subjected to experimental research to determine its relative merits as compared to other methods for the development of strength (1, 2, 15). At least one study has been conducted to determine whether or not weight lifting (one form of weight training) might be deleterious in some ways as well as beneficial in other ways (13). In those respects thus far studied, weight training has shown satisfactory gains in the development of strength and has been responsible for a remarkably low incidence of injury.

There is however, the problem of whether there might be a best method of weight training so far as the development of strength is concerned. This

[1]The writer wishes to express his appreciation to Dr. C. H. McCloy for his helpful assistance throughout this study.

[2]The term *weight training* as used in this study denotes a routine of exercises performed with heavy barbells and dumbbells.

question has been studied and partially answered by Henry (8), Faulkner (7), Teufel (18) and DeLorme (3, 4, 5,).

This study was concerned, first, with a review of related literature to determine the various methods of weight training that are now in use for the development of strength. These methods were then analyzed, and the basically different methods were subjected to experimental study in an attempt to determine the relative merits of each for the development of strength.

Review of Literature

In 1945, DeLorme (3) recommended that heavy resistance exercises, consisting of 70 to 100 executions, with varied weights not to exceed the ten execution maximum,[3] be utilized in prescribing exercise for the patient undergoing physical rehabilitation. In a later publication, DeLorme (5) stated that through further experience he had found that 20 to 30 executions proved far more satisfactory than the 70 to 100 executions. The procedure that was recommended is as follows:

First set of 10 repetitions: Use ½ of 10 repetition maximum
Second set of 10 repetitions: Use ¾ of 10 repetition maximum
Third set of 10 repetitions: Use 10 repetition maximum (sic)

Houtz, Parrish, and Hellebrandt (11) conducted a study concerned with determining the effects of DeLorme's method of resistance exercise on 16 female subjects. They found with these subjects that strength more than doubled in a four-week period of time.

In a study conducted by Walters (19), it was found that a group of 48 subjects performing 10 to 12 executions with a 15 execution maximum load gained more in strength than did a group of 46 subjects that had been performing 20 to 22 executions with a 25 execution maximum load. These results agree with DeLorme's opinion concerning high and low number of executions.

Henry (8) compared DeLorme's method with a variation of the DeLorme method. This variation was as follows:

First set of repetitions: Use 10 R.M.
Second set of repetitions: Use 10 R.M. as many times as possible
Third set of repetitions: Use ¾ of 20 R.M. as many times as possible (sic)

A rest period of three minutes occurred between each set of ten repetitions. There were no significant differences in the results of the two methods.

Faulkner (7) patterned a study after Henry's and compared the DeLorme method with a further variation. This variation was as follows:

First set of 10 repetitions: Use ½ of 10 R.M.
Second set of 10 repetitions: Use 10 R.M.
Third set of 10 repetitions: Use ¾ of 10 R.M. (sic)

---

[3]The terminology *ten execution maximum* means the heaviest weight that can be used successfully performing an exercise a maximum number of ten times. The term *ten repetition maximum* has been widely used and generally accepted; however, "repetition" comes from the same root as "repeat," hence "ten repetitions" would actually mean 11 executions. For this reason, the word "execution" will be used in this study except in the case of direct quotations in which the word "repetition" is used.

A rest period of three minutes occurred between each set of ten repetitions. There were no significant differences in the results of the two methods.

In a third study, Teufel (18) compared the DeLorme method with the following variation:

> Five sets of repetitions in which the subject goes all out each time using the 10 R.M. A rest period of three minutes occurs between each set of repetitions of this exercise.

Teufel found that this variation of DeLorme's method was slightly superior to DeLorme's method in three of the four muscle groups that were tested, so far as the development of strength was concerned.

A review of the popular type of literature (12, 17) reveals many other programs of weight training. However, no scientific evidence is presented so far as the comparative effectiveness of these various programs is concerned in the development of strength. Nevertheless, in the writer's opinion, these programs were worthy of consideration.

After reviewing the literature, it was found that the various recommended methods were really only variations of a few basic programs. These basic programs ranged from the type which employed extremely heavy weights allowing only one execution, to the program which utilized moderately heavy weights permitting from eight to 15 executions. A third program which required a weight to be used that allowed five or six executions was also recommended.

Procedure

PROGRAMS

The basic programs that were selected for this study are as follows:

(1) 8 — 15 E.M. $\times$ *1.*[4] This type of program required the subject to select, for each exercise, the heaviest weight with which he could perform a maximum number of eight executions. Using this weight, the subject then performed as many successive executions for each exercise as he could during each weight training period. This, with the gradual increase in strength, would eventually result in the ability to perform 15 executions. Upon achieving 15 executions, a new 8 E.M. was determined and further exercise was undertaken to again increase the number of executions.

(2) 8 — 15 E.M. $\times$ *1 plus 5 E.M.* $\times$ *1.* The first part of this program was performed in the same manner as in program one. The added set was accomplished by the subject's determining the heaviest weight for each exercise with which he could perform a maximum number of five executions and increasing this weight each time that a gain in strength allowed as many as six executions. A three-minute rest period was taken between the bouts of exercise.

---

[4]The abbreviation "x 1" means that a series of executions was performed only once and then the subject went on to another exercise. Similarly, the abbreviations "x 2" and "x 3" mean that a series of executions was performed two times or three times. When a series of executions was performed a second time this was normally called the second *set*, likewise a third series was called the third *set*, etc. A two- or three-minute rest period was required between sets.

(3) 5 E.M. × 3. The subject selected the heaviest weight with which he could perform a maximum number of five executions. The subject would then perform three sets with this selected weight, performing as many executions as possible in the second and third bouts. When a sufficient gain in strength allowed five executions to be accomplished during each of the three sets, a new 5 E.M. was determined. A three-minute rest period was taken between sets.

(4) 1 E.M. × 3. The subject selected the heaviest weight with which he could perform only one execution. After executing the exercise with the maximum weight, the weight was decreased slightly for the second set and the subject performed as many executions as possible. The same procedure of a slight decrease in weight was repeated for the third set.[5] The subject would be able to perform only one, two, or possibly three executions during the second and third set. A three-minute rest was taken between sets.

SUBJECTS

The four programs that are described above were applied to eight groups in four varied studies. These eight groups and the studies in which they were a part are described below.

Groups A and B. Group A was composed of six male university freshmen who participated in weight training three times each week for a period of 12 weeks. This group of subjects utilized programs one and two in the following manner. Program one was used for the development of strength in the right forearm flexors, left forearm extensors, left arm abductors, right lower leg extensors, and the left lower leg flexors. Program two was used for the right forearm extensors, left forearm flexors, right arm abductors, right lower leg flexors and the left lower leg extensors.[6]

Group B was also composed of six male university freshmen who participated in weight training three times each week for a period of 12 weeks. Group B utilized programs three and four in the same manner as Group A utlized programs one and two. Program three was used for the development of strength in the RFF, LFE, LAA, RLLE, and the LLLF. Program four was used for the development of strength in the RFE, LFF, RAA, RLLF, and the LLLE.

Groups C, D, and E. Group C contained 44 male university freshmen who utilized program one, two times each week for a period of 12 weeks.

---

[5]The decrease in weight ranged from two and a half pounds to five pounds for weights approximately 50 pounds or less. For exercises where the weight was greater than 50 or 60 pounds, the decrease in weight ranged from five pounds to ten pounds.

[6]These muscle groups will be referred to hereafter in the following abbreviated forms: RFF = right forearm flexors, LFE = left forearm extensors, LAA = left arm abductors, RLLE = right lower leg extensors, LLLF = left lower leg flexors, RFE = right forearm extensors, LFF = left forearm flexors, RAA = right arm abductors, RLLF = right lower leg flexors, and LLLE = left lower leg extensors.

Group D contained 42 male university freshmen who utilized program three, two times each week for a period of 12 weeks.

Group E contained 55 male university freshmen who utilized program four, two times each week for a period of 12 weeks.

Groups F and G. Group F consisted of two male university freshmen who participated in program one for a period of 12 weeks. Three days each week the two subjects exercised the RFF, LFE, LAA, RLLE, and the LLLF. Five days each week the two subjects exercised the RFE, LFF, RAA, RLLF, and the LLLE.

Group G consisted of two male university freshmen who participated in program three for a period of 12 weeks. Three days each week the two subjects exercised the RFF, LFE, LAA, RLLE, and the LLLF. Five days each week the two subjects exercised the RFE, LFF, RAA, RLLF, and the LLLE.

Group H. Group H consisted of two male university freshmen who took part in program three, three days each week for a period of 12 weeks on the RFF, LFE, LAA, RLLE, and the LLLF. During the same exercise periods, a modification of program three was used on the RFE, LFF, RAA, RLLF, and the LLLE. This modification involved increasing the number of executions accomplished without increasing weight; i.e., when the subjects were able to accomplish five executions on each of the three sets, they would increase the first set to seven executions and continue with as many executions in the second and third set as possible. Again, as seven executions were successfully accomplished, two additional executions were added to the first set, etc.

STRENGTH TESTING

A strength test was administered to all eight groups at the beginning of the 12-week period and again at the conclusion of this period. For Groups A, B, F, G, and H, the strength test was applied to the RFF, RFE, LFF, LFE, RAA, LAA, RLLF, RLLE, LLLF, and the LLLE. Groups C, D, and E received the strength test on the RFF. The methods used in measuring the strength of the specific muscle groups are described below.

Forearm flexors. The subject was placed in a supine position with the forearm raised so as to form a 90° angle at the elbow joint. A three-inch-wide leather loop which was connected by a lightweight chain to a push and pull attachment containing a manuometer was placed around the wrist joint. On the command "pull," the subject would exert his maximum pull which was recorded on the manuometer. The angle of the chain and forearm was 90°. The test was repeated several times and the strength reading of the strongest pull was recorded.

Forearm extensors. The position and method was the same as used for the forearm flexors except that the pull was in the opposite direction.

Lower leg flexors. The subject was placed in a prone position with the lower leg raised so as to form a 90° angle at the knee joint. The leather loop of the strength-testing equipment was placed around the ankle joint directly over the malleoli. The angle of the chain and the lower leg was 90° and the method of determining the strongest pull was the same as for the forearm flexors.

Lower leg extensors. The position and method was the same as used for the lower leg flexors except that the pull was in the opposite direction.

Arm abductors. The subject placed himself about four feet from the connection on the floor which contained one end of the strength-testing equipment. The arm to be measured was abducted to a point 45° from the body and the leather cuff placed around the wrist. The angle of the chain and the arm was 90° and the method of determining the strongest pull was the same as for the forearm flexors.

Findings

The changes in strength between the test results at the beginning and at the end of the 12-week period of training are discussed below.[7]

GROUPS A AND B

The findings for Groups A and B are shown in Table 1.

TABLE 1

*Improvement in Strength in Programs 1, 2, 3, and 4 (Groups A and B)**

Programs	Initial Strength	Final Strength	Gain	Level of Significance		
				Program Two	Program Three	Program Four
Program 1 Mean	228.3	271.3	43.0	22%	56%	44%
Program 2 Mean	224.5	271.5	47.0	.....	70%	56%
Program 3 Mean	241.2	291.2	50.0	.....	.....	52%
Program 4 Mean	242.7	293.7	51.0	.....	.....	.....

*N = 6 for both group A and group B.

The amount of strength that was gained from each of the four programs was found to be nearly equal. Program four which showed the largest increase in strength was significant at only the 44-per-cent level when compared with program one which had the smallest increase in strength.[8]

[7]The levels of significance were all computed by the use of t-formulas. The t-formulas that were used for related and unrelated measures may be found in E. F. Lindquist, *Statistical Analysis in Educational Research*, pp. 56-59. In most published texts concerning statistics, the tables on the significances of differences list only the 1%, 2%, 5%, and two or three other values. The writer considers this to be unfortunate. When, for example, a "t" value falls between two listed values, the reader frequently wishes that he could ascertain the exact level of significance. For this reason, the writer has used a table computed from Student's tables in *Metron*, No. 3, 5: 105, 1925. This table gives levels of significance from 0 to 100.

[8]Levels of significance for such small numbers as two are of dubious significance. If the levels of significance are better than the 5% level, the results may be thought-provoking. Differences in the rate of increase of strength upon the part of two individuals, however, may be due not to differences in the programs, but to differences in the endocrine makeups of the individuals. However, since the writer tried certain programs (programs one, three, and four) with larger groups, the results as computed are reported here for their values as suggestions for further research.

Table 2 was included to show the percentage of increase for the individual muscle groups in programs one, two, three, and four. It can be seen from this table that the weak muscle groups normally gain muscular strength more rapidly than the strong muscle groups. For example, the LFE was weaker than the RFE on all subjects prior to the weight training program. At the conclusion of the weight training program both Group A and Group B showed a larger percentage gain in muscular strength in the LFE than in the RFE.

TABLE 2

*Improvement of Strength in the Individual Muscle Groups in Programs 1, 2, 3, and 4 (Groups A and B)**

Groups	Group A		Group B	
	Program One	Program Two	Program Three	Program Four
RFF	60		84	
RFE		19		33
LFF		77		83
LFE	28		33	
RLLF		49		83
RLLE	89		95	
LLLF	66		77	
LLLE		113		94
RAA		24		13
LAA	27		11	
Mean Gain	54.0	56.4	60.0	61.2

*N = 6 for both group A and group B.

These findings were expected; hence, the method of allocating the programs to the individual muscle groups was done in such a way so as to obtain comparable results. The system that was used in pairing the programs with the muscle groups was described previously in the procedure.

An additional observation is that the gains of the individual muscle groups for both Group A and Group B were generally in favor of Group B with the exception of the RAA and LAA. The writer has no explanation or theory as to why this occurred.

GROUPS C, D, AND E

The findings for Groups C, D, and E are shown in Table 3.

Group E gained more in strength than did either Group C or D. This superior gain in strength, when compared with Group C, was significant at the 3-per-cent level of confidence, and significant only at the 27-per-cent level of confidence when compared with Group D.

Group D, while gaining less strength than Group E, did gain more than Group C. This difference was significant only at the 23-per-cent level of confidence.

It will be noted that there was a rather large difference in the amount of muscular strength that was gained by Groups A and B as compared with Groups C, D, and E. This difference was probably due to the fact that

Groups A and B formed a very small class which allowed more adequate individual motivation and also that these subjects were volunteers who were extremely serious about their efforts toward strength improvement. Groups C, D, and E were larger classes and hence received less individual attention and instead of being volunteer subjects they were students in a regular weight training class.

TABLE 3

*Improvement in Strength in Programs 1, 3, and 4, Utilizing Only the Right Forearm Flexors (Groups C, D, and E)**

Group	Initial Strength	Final Strength	Gain	Level of Significance	
				Group D	Group E
Group C					
Mean	61.21	63.68	2.47	23%	3%
Group D					
Mean	61.07	65.33	4.26	.....	27%
Group E					
Mean	58.86	64.40	5.54	.....	.....

*N = 44 for group C.
N = 42 for group D.
N = 55 for group E.

GROUPS F AND G

The findings for Groups F and G are shown in Table 4.

TABLE 4

*Improvement in Strength in Programs 1 and 3 Performed Both on Alternate Days and Daily (Groups F and G)**

Group	Initial Strength	Final Strength	Gain	Level of Significance 5 Times/week
Group F				
3 times/week				
Mean	220.5	276.0	55.5	50%
5 times/week				
Mean	221.5	278.0	56.5	.....
Group G				
3 times/week				
Mean	258.0	339.5	81.5	6%
5 times/week				
Mean	267.5	327.0	59.5	.....

*N = 2 for group F.
N = 2 for group G.

From the results of Group F, which utilized program one, there was practically no difference in the amount of muscular strength that was developed in the muscle groups that were exercised three days each week and the muscle groups that were exercised five days each week. These results were significant at only the 50-per-cent level of confidence.

The two subjects who formed Group G, and were participating in program three, gained more muscular strength in those muscle groups that were ex-

ercised only three days each week than in the muscle groups that were exercised five times each week. This difference was significant at the 6-per-cent level of confidence.

GROUP H

It can be seen from Table 5 that so far as Group H was concerned there does not appear to be any difference in the two methods of performing program three. This difference in the results was significant at only the 50-per-cent level of confidence.

TABLE 5

*Improvement in Strength in Program 3 Performed Both by Increasing the Weight and Increasing Only the Number of Executions (Group H)**

Type of Increase	Initial Strength	Final Strength	Gain	Level of Significance Increase Only No. of Executions
Increase Weight Mean	224.5	289.0	44.5	50%
Increase Only the Number of Executions Mean	244.0	287.5	43.5	——

*N = 2 for group H.

Discussion

As was stated earlier, DeLorme (5) found that 30 executions were more satisfactory than 70 or 100 executions in the development of muscular strength. Walters (19) found that ten or 12 executions proved to be better for the development of muscular strength than 20 to 22 executions.

The present study employed weight training programs that entailed still fewer executions, and from the results of Groups A and B, and particularly from the results of Groups C, D, and E, it can be seen that those weight training programs that utilized the heaviest weights that would permit a maximum number of five executions were superior to the other programs in this study, for the development of muscular strength.[9]

Program three, which was used by Group F, was slightly more effective in the development of muscular strength when followed three days each week rather than five days each week. It is quite possible that in employing heavier weights than were used in program one, a longer period of time was required for the physiological recuperation of the muscles. The superiority in the amount of muscular strength that was gained when participating in program three, three days each week rather than five days each week was statistically significant at the 6-per-cent level of confidence. This finding—that heavy exercise three times a week, or on alternate days, is sufficient—is in agreement with the empirical findings of weight lifters (10).

[9]There is, of course, the qualification that exercises with a near-maximum weight should not be prescribed for a person in extremely poor physical condition; i.e., for any post-operative patient, for persons who have not exercised for many years, or for aging persons with blood vessels which might be subject to rupture by increased arterial pressure.

It is possible that the subjects who utilized two methods at the same time (Groups A, B, F, G, and H) were receiving "cross exercise" or transfer of effect to the other limbs from the limb being exercised (16). However, inasmuch as the weight training exercises were being applied to both arms and both legs, any transfer of effect from one exercised limb to another limb should have been compensated for when the other arm or leg received the exercise and the transfer of effect was reversed.

After this study had been completed, some research that had been conducted in Germany came to the writer's attention (9). Hettinger and Müller found that with static (isometric) contraction, muscular strength increased an average of 5 per cent each week when the training load was as little as ⅓ of the maximal strength. When ⅔ of the maximal strength was used, in static contraction, the optimum amount of strength increase was achieved. They further stated that when the exercises were performed once a day and the tension held for six seconds as much increase in strength resulted as for longer and more frequent periods.

The results of this study by Hettinger and Müller do not agree with the results of the writer's study. However, it should be noted that two different types of muscular contraction are involved and no real comparison can be made. Hettinger and Müller attribute their results to the fact that prolonged isometric contraction result in anoxia in the muscles. In programs two and three, but more especially four, the movements are so slow that there is a high probability that a considerably prolonged period of anoxia is produced. This may be at least a partial explanation for the results found. In order that a future comparison can be made, additional research is needed to study the comparative effects of isometric muscular contraction and isotonic muscular contraction so far as the development of muscular strength is concerned.

Conclusions

1. The findings of this study indicate that the 1 E.M. × 3 program is superior to the 8 — 15 E.M. × 1 program for the development of muscular strength. This superiority is significant at the 3-per-cent level of confidence, as may be seen in Table 3.

2. From the findings of this study, it appears to make little difference whether the 8 — 15 E.M. × 1 program is utilized three days each week or five days each week. However, the evidence is not statistically significant and N equalled only two in the group studied.

3. The 5 E.M. × 3 program appears to be more satisfactory in the development of muscular strength when used three days each week rather than five days each week. The difference in the gains in strength is significant at the 6-per-cent level of confidence; however, N equalled only two in the group studied.

4. So far as this study is concerned, there is not a statistically significant difference in the gains of muscular strength when weight and the number of

executions are both increased, as compared with when only the number of executions is increased and the original 5 E.M. weight remains unchanged.

REFERENCES

1. CAPEN, EDWARD K. The effects of systematic weight training on power, strength, and endurance. *Research Quarterly*, **21**: 83-93, 1950.
2. CHUI, EDWARD. The effects of systematic weight training on athletic power. *Research Quarterly*, **21**: 188-194, 1950.
3. DELORME, THOMAS L. Restoration of muscle power by heavy resistance exercises. *The Journal of Bone and Joint Surgery*, **27**: 607-630, 1946.
4. ———. Heavy resistance exercises. *Archives of Physical Medicine*, **27**: 607-630, 1946.
5. ———. Technics of progressive resistance exercise. *Archives of Physical Medicine*, **29**: 263-273, 1948.
6. ———. *Progressive Resistance Exercise*. New York: Appleton-Century-Crofts, 1951, 245 pp.
7. FAULKNER, EVERETT W. *A Comparison of the Effectiveness of Two Methods of Exercise for the Development of Muscular Strength*. Unpublished Master's thesis, State University of Iowa, Iowa City, 1949, 30 pp.
8. HENRY, CLAYTON G. *A Comparison of the Effectiveness of Two Methods of Exercise for the Development of Muscular Strength*. Unpublished Master's thesis, State University of Iowa, Iowa City, 1949, 29 pp.
9. HETTINGER, THOMAS, and E. A. MÜLLER. Muskelleistung und Muskeltraining. *Arbeitsphysiologie* 15, 1953.
10. HOFFMAN, BOB. *Simplified System of Barbell Training*. York: York Barbell Co., 1941.
11. HOUTZ, SARA JANE, *et al.* The Influence of heavy resistance exercise on strength. *The Physiotherapy Review*, **26**: 291-298, 1946.
12. *Iron Man*. Alliance, Nebr.: Iron Man Publishing Co.
13. KARPOVICH, PETER V. Incidence of injuries in weight lifting. *Journal of Physical Education*, **48**: 71-72, 1951.
14. LINDQUIST, E. F. *Statistical Analysis in Educational Research*. Chicago: Houghton Mifflin Co., 1940, 264 pp.
15. MASLEY, JOHN W., *et al.* Weight training in relation to strength, speed, and co-ordination. *Research Quarterly*, **24**: 308-315, 1953.
16. SLATER-HAMMEL, ARTHUR T. Bilateral Effects of muscle activity. *Research Quarterly*, **21**: 203-209, 1950.
17. *Strength and Health*. York, Pa.: Strength and Health Publishing Co.
18. TEUFEL, WILLIAM F. *A Comparison of the Effectiveness of Two Methods of Exercise for the Development of Muscular Strength*. Unpublished Master's thesis, State University of Iowa, Iowa City, 1952, 33 pp.
19. WALTERS, BERNARD R. *The Relative Effectiveness of High and Low Repetitions in Weight Training Exercises on Strength and Endurance of the Arms*. Unpublished Master's thesis, State University of Iowa, Iowa City, 1949, 20 pp.

(Submitted 7/12/55)

Effect of Preliminary Passive Warming on Swimming Performance

FORBES CARLILE
University of Sydney, Australia

Abstract

The effect of preliminary heating by eight-minute hot showers was investigated in a group of male swimmers who made more than 400 trial swims. There was found an improvement of one per cent in comparison with trials without preliminary heating. The difference in performance was statistically highly significant. Evidence is presented that the improvement could not be explained psychologically as the result of suggestion. Practical applications to the athlete of passive warming are considered. Examples of the results of such techniques used with some Australian Olympic swimmers are given.

THE VIEW THAT athletic performance is improved by adequate "warming up" by physical activity has for a long time been widely held by coaches and athletes in most sports.

Asmussen and Boje (1), using the bicycle ergometer, concluded that when the body was at a higher temperature than normal, work output was increased. They showed that warming the body, not only by preliminary muscular activity but by passive heating with radio diathermy and hot water, resulted in improved ergometer performances. Asmussen and Boje found a close relationship between work output and the muscle temperature, but not between work output and rectal temperature.

Although passive warming was shown to improve bicycle ergometer performance, without investigation it cannot be assumed that swimming performance is similarly improved. Conceivably, the effect of cold water after the plunge could make preliminary heating unfavorable for swimmers. In fact the general opinion among swimmers, other athletes, and coaches would appear to be that hot water is enervating. Pre-race passive heating is generally considered to be detrimental.

The purpose of this study was to investigate the effects on swimming speed of pre-heating the body with hot water.

Experimental Procedure

The subjects consisted of the author (a 26-year-old male), on whom the first experiment was performed, and for the other experiments a group of young swimmers between 13 and 20 years of age, who were training in the off-season in a 20-yard indoor pool. Here the water and the ambient temperature were kept at about 72° F. In the first experiment the test distance was 220 yards, but in the subsequent three experiments 40 yards (2 laps) were swum in each trial.

By using relatively short test-swim distances, the variation due to faulty pace judgment was kept to a minimum and it was possible to carry out two and sometimes three trials each week without fatiguing the subjects unduly.

The swimming was unpaced. Each trial was always made the first swim of the training session. The timing stop watch registered ten seconds around the dial and so could be easily read to the nearest 1/10 second. The watch was checked regularly.

In experiments 3 and 4, rectal temperatures were taken at a constant depth of 7 cm. with clinical thermometers left in position for at least two minutes.

Because the effect of warming was expected to make only small differences to swimming times for 40 yards, it was recognized as important to take special precautions to reduce random timing errors as much as possible if statistically significant differences were to be shown. To minimize the effect of variation due to the reaction time of the swimmer which would be largely dependent on the subject's attention, the watch was always started at the moment the swimmer's feet were judged to have left the starting board. This method was considered preferable to using a signal to start, because it would be conducive to less experimental error. Warned by preparatory movements on the part of the subject, the time-taker had a good opportunity to judge the take-off with a minimum of error. Judging the finish was more diffcult. It was attempted always to stop the watch immediately the subject touched the wall, either above or below the water line.

The general plan adopted was to alternate pre-heated test swims with control swims when the subject was not heated by a hot shower. Because it was necessary for reasons of pool hygiene to wash before entering the water, the control swims were made after a half minute lukewarm shower. The hot shower used for pre-heating was standardized as being as hot as the subject could comfortably tolerate, generally about 105° F. There was always a copious flow of hot water from the shower and the subjects usually came from it reddened and steaming.

EXPERIMENT I.

The author was the subject for this experiment. He had been swimming a total distance of between 2 and 3 miles each week during the preceding six months. When the experiment was started, he swam two trials each week, always with at least one rest-day between the 220 yards time trials. In addition, each week he covered an additional average distance of between 220 yards and 440 yards.

After the first 9-time trials, each one made after half-minute showers which were lukewarm, there were spaced arbitrarily between control swims, time-trials made after 8 minutes under the hot shower. The criterion as to whether a pre-heated trial would be carried out was whether time was available that day before the author carried out coaching duties.

The graphed results of this experiment are shown in Figure I.

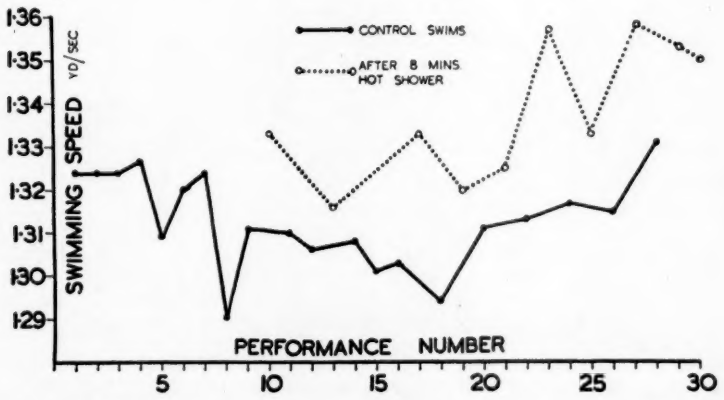


FIGURE I. Results of Experiment I; in Which the Author Was the Subject, Comparing Average Speed of Pre-heated Swims with Control Swims.

There is a noticeable decline in swimming speed during the first 17 performances while the subject was getting more out of training. The gradual improvement towards the end of the experiment is explained by the fact that the subject increased the amount of general swimming to about a mile a week.

The average speed of the pre-heated swims (which followed the 8-minute hot shower) was compared with control swims which immediately preceded. From the variation of the differences of these paired performances, a t-value of 5.27 was calculated. This indicated a highly significant difference ($P = 0.01$) between the control and pre-heated test swims. The average improvement in the swimming time after the passive heating was 3 seconds. Since the control swim times were in the order of 2 minutes 47 seconds, the improvement was approximately 1½ per cent.

EXPERIMENT II.

Ten swimmers were the subjects for this experiment. Three subjects swam at two strokes, changing over midway through the experiment. For alternate performances a lukewarm half-minute shower and an 8-minute hot shower were used. A total of 230 trials were made and the t value for the variation of the differences between paired hot shower and control performances was calculated. Because alternate pairs of trials were compared, the effect of improvement due to training was thus virtually eliminated and the difference between performances may be considered as due to the warming effect and chance variations. The possible effect of suggestion is considered in Experiment III.

The results of this experiment are shown in Table 1. Unless otherwise stated, the stroke used was the crawl.

TABLE 1

A Comparison of the Effect of an Eight-Minute Hot Shower with a One-Half-Minute Lukewarm Shower, Upon Swimming Speed

Subject	No. of performances	Avg. time of control swim (sec.)	Avg. difference of hot shower swims	t Value	Probability of FASTER performance	Probability of SLOWER performance
G. T.	20	22.62	+0.24	3.43	P=0.01*	
J. D. (Crawlstroke)	8	22.55	+0.40	6.94	P=0.01*	
J. D. (Butterfly)	18	23.81	+0.24	1.44	P=0.2	
R. J.	22	19.66	−0.05	1.50		P=0.2
P. V.	22	18.31	−0.01	2.71		P=0.05**
T. D.	26	19.26	+0.22	2.87	P=0.02**	
T. J.	22	21.38	+0.10	1.03	P=0.3	
V. R. (Crawlstroke)	20	19.69	+0.32	4.15	P=0.001*	
V. R. (Backstroke)	8	22.85	+0.55	3.22	P=0.05	
F. S.	18	23.63	+0.40	2.49	P=0.05**	
K. J. (Crawlstroke)	20	19.79	0			
K. J. (Butterfly)	10	22.90	+0.16	1.11	P=0.4	
B. P.	16	19.12	+0.44	2.23	P=0.1	

*Significant at 1% level.
**Significant at 5% level.

Only one subject (P. V.) showed a statistically significant decline in performance after the 8-minute hot shower. Six of the ten swimmers showed a statistically significant or highly significant improvement.

The over-all comparison of experimental swims with control swims when the group results were considered gave a t-value of 5.35 which was highly significant ($P = 0.001$).

Bearing in mind the reservation that an 8-minute hot shower may be too long for some individuals, it was concluded that the group as a whole showed a significant average improvement of close to 1 per cent with the 8-minute hot shower.

EXPERIMENT III.

It was considered that *suggestion* of improvement might well play a part in influencing the performance after the hot shower. This experiment was designed to investigate whether the subjective feelings of the swimmers had any important effect.

Most of the subjects freely expressed the opinion throughout the investigation that hot water was "weakening." They did not expect improvement in performance after a relatively long hot shower, although most said that a half-minute hot shower made them feel comfortable. All expressed the belief that a preliminary half-minute hot shower would result in a better time than a preliminary 8-minute hot shower.

Half-minute and 8-minute hot showers were used alternately for each subject. Rectal temperatures immediately before and after the showers were taken. The results of this experiment are shown in Table 2.

TABLE 2

Individual Mean Times of Six Subjects in Forty-yard Swimming Trials After Half-Minute and Eight-Minute Pre-Performance Hot Showers

Subject	No. of Performances	Time for 40-yards after half-minute hot shower (sec.)	Time for 40-yards after 8-minute hot shower (sec.)
R. S.	14	19.83	19.80
F. J.	10	20.26	20.22
D. H.	8	22.45	22.09
T. S.	6	20.45	20.10
L. O'K.	8	20.56	20.34
B. K.	10	19.52	19.38

Although the subjects were prejudiced strongly in favor of the short hot shower, the results of the experiment (Table 2) showed an average group improvement of 0.19 seconds when the longer shower period was used. Considering the paired performances, a t-value of 2.79 was obtained for the group. This showed a highly significant difference beyond the $P = 0.01$ level.

The mean rectal temperatures were 100.01° F. and 100.39° F. after the half-minute and 8-minute hot showers, respectively.

The additional seven and one-half minutes of hot shower between the two pre-heating periods resulted in an average improvement of 0.9 per cent, the result being compatible with the finding in Experiment II where the 8-minute hot shower improved performance by 1 per cent.

It was concluded that in spite of the mental set of the subjects being opposed to improvement, the significant improvement in performance, with the longer shower periods, disposed of any psychological explanation of the beneficial effect.

EXPERIMENT IV.

This experiment was designed to investigate the dependence of performance on deep body temperature, as measured by rectal temperature. Five subjects made a total of 117 trials where the pre-heating time was varied randomly between no pre-heating and up to 16 minutes under the hot shower.

Rectal temperatures were taken immediately before the subjects made their time trial swims. It was found that these rectal temperatures ranged in the five subjects between 98.8° F. and 101.6° F. Personal best performances were made when rectal temperatures lay between 99.1° F. and 100.9 ° F.

Two factors were taken into account in making a statistical analysis of the results. It was obvious that the effect of training, represented by performance number in the following analysis, would tend to improve in the later trials. Further, there was the likelihood of a curvilinear relationship between rectal temperature and trial time.

It had been shown in Experiment III that a mean rectal temperature of 100.39° F. (SD 0.12) was associated with an average improvement in time of 0.9 per cent but in this experiment it was found that when rectal temperatures reached about 101° F. (which generally required between 8 and 16

minutes under the hot shower), there was a lowering of the trial times, clearly seen when the pooled data of the group was graphed. Thus for the purposes of making a statistical analysis a linear relationship only up to a rectal temperature of 100.5° F. was assumed, and data associated with rectal temperatures above this value were rejected from the analysis.

Two rank-order partial correlations were calculated, firstly for performance number and time for the 40-yard swim with the rectal temperature held constant, and secondly for rectal temperature and time for the 40-yards with the effect of performance number (i.e., the effect of training) held constant.

The results of these partial correlations are shown in Table 3.

TABLE 3

The Effect of Partialling Out Training Effects and Rectal Temperature Upon Correlations Between Swimiming Speed and the Respective Variables — Body Temperature and Training

Subject	No. of performances	Partial correlation of swim. time and performance number with rectal temperature partialled out	Partial correlation of swim. time and rectal temperature with performance number partialled out
R. S.	21	−0.75*	+0.17
B. K.	20	−0.62*	+0.19
L. S.	16	−0.51**	+0.05
F. S.	19	−0.52**	−0.34
D. H.	12	−0.48	+0.65*

*Significant at 1% level.
**Significant at 5% level.

It was found that in four out of the five subjects there was a fairly high negative partial correlation between time for 40-yard swim and performance number where the rectal temperature factor was held constant. Thus the effect of training alone acted, as would be expected, to reduce the time for the swim.

The partial correlation between time and rectal temperature, with the effect of training held constant, gave a significant correlation in the case of only one swimmer. Subject D. H. showed a statistically significant positive correlation of 0.65, indicating that his times were slowed by increase in rectal temperature even towards 100.5° F.

A regression analysis made for each subject confirmed that the introduction of rectal temperature as a variable did not help significantly in the prediction of time from performance number. It is interesting that the subject who showed a significant decrease in performance with increased temperature nevertheless did show a significant improvement in performance in Experiment III when the 8-minute hot shower was used. With the longer hot shower periods in Experiment IV, this subject showed clearly that his performance declined markedly as the heating time exceeded 8-minutes duration.

From Experiment IV it was concluded that for rectal temperatures below 100.5° F. the swimming time was in general unrelated to rectal temperature except in one subject who recorded slower times as his rectal temperature approached 100.5° F.

Discussion

The finding that performance was in general unrelated to rectal temperature, which was in agreement with Asmussen and Boje (1), requires interpretation for, since pre-heating has been shown to help performance, the lack of correlation is a seeming paradox.

Reader and Whyte (2) provide the explanation. In their study of variations of muscle temperature, which they measured with needle thermocouples, it was not unusual for them to record deep muscle temperatures 5°-6° C. below blood temperature. Hence, a low correlation between muscle temperature and blood temperature would appear most likely. Muscular performance would be expected to be more closely relately to muscle temperature than to blood temperature if there were any marked differences between the two dependent variables. Indeed, Asmussen and Boje (1), as well as the present writer (unpublished data) have shown a high correlation between muscle temperature and performance by those muscles concerned in the work. The writer was able to confirm the finding of the Scandinavian workers that at around normal blood temperature 1° C. made a difference in performance of about 4 per cent.

Reader and Whyte (2) showed that cooling the skin surface quickly caused a reflex constriction of vessels in underlying muscle. Thus, it would be easy to conceive of a situation where the athlete may have a high rectal temperature accompanying a low temperature in several muscle groups important to his activity. Such considerations are important from the practical point of view where maximum performance is required of the athlete.

Acting on the conclusions drawn from these data, the author, who was present in London as coach to the 1948 Australian Olympic Swimming Team, had some swimmers on the team take a four-minute hot bath at between 108° F. and 110° F. They did this immediately before going to the starting board for their Olympic events. Three out of four of the swimmers made personal record performances. Nancy Lyons (breaststroke) was 2nd, John Davies (breaststroke) was 4th and Marjorie McQuade (crawl stroke swimmer) was a semi-finalist, in their respective Olympic races.

It would be difficult to show with statistical significance the suspected beneficial effect of the preliminary hot bath, as any such experiment with baths would be limited by facilities. However, it appears not unlikely that the hot bath like the hot shower would improve performance to the extent of about 1 per cent. On the sporting arena, even a 1-per-cent difference in average speed is of considerable importance. The writer found, empirically, that in regard to the raising of rectal temperature, a hot bath for four minutes was equivalent to a hot shower of eight minutes duration.

It should be pointed out that subject D. H. (David Hawkins, who was the winner of the 1950 British Empire Games breaststroke championship and the 9th fastest breaststroke swimmer at the 1952 Olympic Games) has always insisted on a two-minute hot bath or a shower of relatively short duration.

Hawkins' subjective feelings confirmed the experimental finding that at higher rectal temperatures his performance deteriorated.

It is likely that every individual would have his optimum amount of passive heating which would allow him to produce his best performance. Eight minutes hot shower was originally chosen more or less arbitrarily. Further research on the individual swimmer would be necessary to determine his optimum amount of passive heating. Obviously, the time would depend on body weight, peripheral blood flow, and personal idiosyncrasy. It was noted that individual performances seemed to become rather less variable after prerace heating with the hot bath used as a standard procedure by the author.

Apart from the general nature of the training, in the author's opinion, the two factors which most affect the individual's performance are pace judgment in the race and the temperature of the muscles which will be most active. Swimmers and other athletes who have been resting for an event can easily have their muscles drop many degrees below blood temperature, as has been shown by measurements of deep muscle temperature made by the author (unpublished data).

When warming-up is adequately carried out, whether it be effected by active (physiological) or passive (pre-heating) means, it would appear to be a factor which can in practice be fairly easily controlled, thus helping to keep the athlete's performance close to his best.

Hipple (3), using 12- to 13-year-old boys, has shown that after active warm-up, in the form of running a 50-yard test distance at maximum effort, that subsequent performances were not improved. He interprets his results as indicating that there is too much credence placed generally on the need for warming-up. However, Hipple's conclusions may be criticized on several grounds. The boys were relatively untrained, so that fatigue might be expected to manifest itself earlier than in trained subjects. His subjects waited for five minutes between runs. Hipple makes no mention of ambient temperature or of the boys putting on track suits or other clothing while waiting for their next trial. The present author has observed that when the skin above previously active muscles is exposed to still air at about 70° F. there may be a drop in deep muscle temperature of several centigrade degrees in five minutes. Further, it is unlikely that an all-out run would constitute the best method of warming-up.

Hipple says: "Dr. Maxwell Howell, a former Australian rugby star, has stated to the writer that athletes and coaches in that country laugh at the American system of tiring the athlete by warming-up before a race. The Australian method is to use massage." This statement does not represent the true picture in Australia as observed by the present writer. Swimmers and athletes of note for the past five or ten years have in general devoted considerable time to preliminary stretching and limbering exercises and general physical activity. Massage, except by football players, is *not* extensively used.

Physical exercise has the effect of warming the active muscles, but with some concomitant fatigue. The best kind of warming-up would seem to be represented by blending both active and passive methods of raising blood and muscular temperature to an optimum value.

Summary and Conclusions

1. A subject showed an improvement in swimming performance in 220-yard swims of 1½ per cent followed 8-minute hot showers. The difference in swimming speed was statistically significant.

2. Ten swimmers in 230 trials with various strokes showed an improvement of 1 per cent for 40-yard time trials when the swims were preceded by 8-minute hot showers. A statistical consideration of the group data showed the difference in swimming speed between control and pre-heated swims to be highly significant.

3. Evidence is presented that it is unlikely that the improvement in performance can be explained on psychological grounds.

4. Performance was found to be not closely related to rectal temperature. This is explained by the fact that muscle temperature is known to vary independently of rectal temperature and that muscle temperature has a more important influence on performance.

5. The practical applications for athletes of the findings are discussed and criticism is offered in negation of a published conclusion that warming-up is relatively unimportant.

6. It is suggested that at least in temperate climates, some passive pre-race heating of the body, in addition to some active work, constitutes a valuable adjunct to the warming-up procedure.

REFERENCES

1. Asmussen, E. and O. Boje. Body temperature and capacity for work. *Acta Phys. Scand.*, **10**: 1, 1945.
2. Reader, S. R., and H. W. Whyte. Tissue temperature gradients. *J. Applied Physiology*, **396**: 4, 1951.
3. Hipple, J. E. Warm-up and fatigue in junior high school sprints. *Research Quarterly*, **26**: 246-247, 1955.

(Submitted 9/7/55)

Proposed Method for Analyzing Sociometric Data

PATRICIA WHITAKER HALE
Santa Barbara College
Goleta, California

Abstract

Sociometry is a promising evaluative technique for determining individual social status and group integration. So far, however, there does not exist a satisfactory constant frame of reference against which data can be compared so that a value judgment may be given. It is the purpose of this paper to present a set of criteria to serve as this constant frame of reference. Five criteria are stated. Data on a test and retest are set up, organized, and analyzed according to the criteria to demonstrate the use of data and application of the criteria.

EVALUATION TO determine the status and progress made in the achievement of the social objectives of physical education has been a persistent problem to physical educators and to teachers in general. A large step forward has been taken within the past ten years by the use of several forms of sociometric tests in physical education classes. The tests are easy to administer (9, *p. 13*); and the sociograms formed from student choices have provided a workable method of forming teams, squads, and committees which bring together students who work well as a unit and produce desirable results through efficient group efforts.

Sociometric data are easy to gather, the tabulation chart and rank listing charts are easy to make, the sociogroups take a few rearrangements to form. However, the actual use of sociometric data for evaluation is more difficult. The data do not lend themselves to the usual statistical procedures, although many efforts have been made to find techniques that are applicable (3, 5, 7, 8, 11, 15). Statistical techniques which have been tried are: percentile, standard deviations, binomial and multinomial expansion, and a dual deviation technique. However, none of these procedures has proved to be satisfactory for the teacher.

In discussing the use of sociometric data in the book *Theory and Practice of Psychological Testing*, Frank Freeman concluded: (6, *pp. 454-455*)

Since the purpose of the sociometric technique is not to measure the personality of each individual but to measure the environment of opinion in which he lives, it is gratuitous to ask for or expect evidence of validity in the usual psychometric terms. The discovery of the environment of opinion in which an individual lives is none the less important; for such information helps to explain that person's behavior as well as the organization of the group and its values.

Freeman explains further that scores have been expressed in terms of their deviation from chance expectancy, using chance distribution of choices as the common reference base. "While this method provides more refined statistical

data, actual calculations show that little is lost in accuracy when the raw score, rather than the probability index, is used as a measure of sociometric status." (6, *p. 454*) The raw score will tell that Johnny is an isolate and Mary a star just as an average of ten bowling scores will give Johnny a score of 66 and Mary one of 165. For bowling we have the perfect game of 300 and tournament scores against which to compare students' scores and make a value judgment. For sociometric data, a similar constant frame of reference is needed.

Purpose of This Paper

It is the purpose of this paper to present a set of criteria to serve as this constant frame of reference against which data from a test, from a test and retest on the same group, and from tests on two different groups can be compared. Such comparisons enable value judgments to be made and increase the worth of the sociometric test as an evaluative technique to measure individual and group social status and growth.

The procedure for arriving at this frame of reference was determined in the following way. The literature on group growth was studied to ascertain the desirable directions of growth and the characteristics of the completely mature and completely integrated group. Literature on the growth patterns and social needs of individuals was also studied to determine the sociometric responses of the well-adjusted and the poorly adjusted individuals.

The literature served as a basis for picturing an ideal group and its responses to sociometric test. Since it is improbable that any group would reach this absolute state of perfection, the criteria were stated in relative rather than absolute terms. These criteria are presented below.

Criteria

1. *The fewer isolates in the group, the better.* Isolates are those who choose no one, who are not chosen, or who have no reciprocated choices.

2. *The higher the total number of reciprocated choices within the limits of the number of choices allowed, the better.* When three choices are permitted the total number possible is about one and one-half times the number of group members. For four choices, the maximum is twice the class members; for five choices, two and one-half times; for six choices, three times, etc.

(a) Each person uses all his choices.

(b) On a retest, it is an improvement if those who did not receive a reciprocated choice now do so, if the total number receiving reciprocated choices increases, and if the total number of reciprocated choices for the group increases.

3. *As the group matures, the number of overchosen decreases, and the choices are shared by all.*

4. *The acceptance curve* (found by plotting the acceptance score and the number of people receiving that score), *which is ordinarily J shaped* (3, *p. 379*), *takes the shape of a normal curve with the peak of the curve over the theoretical mean.* The mean is the average weighted score times the number

of choices allowed (15, *p. 224*). This trend pursued to the ultimate would result in no curve at all, since in the ideal group where choices are equally shared, all would receive the score of the theoretical mean.

5. *Structural analysis of the sociogram reveals a highly differentiated, all-pervading network.* As a group matures, the structure of the sociogram changes. The progressive stages of group growth, with corresponding sociometric structure for each stage, are:

Stage 1. During the individual-centered stage and as those accustomed to leadership attempt to assume this role in the new group, the sociogram would reveal a few stars, many unchosen, and a few mutual pairs.

Stage 2. As members become better acquainted, they begin to form pairs. The sociogram would show an increase in the mutual pairs and possibly short chains.

Stage 3. This is a period of frustration as the leader steadfastly refuses to assume an authoritarian role. Also, there is conflict among the members as they vie for stereotyped roles. During the period of frustration, some subgroups of like-minded individuals would form, while others would psychologically withdraw. The sociogram would be characterized by isolated structures and isolates.

Stage 4. Individual self-assessment and attempted consolidation occur. There is a development of cohesiveness among members which is accompanied by a certain amount of smugness and complacency. This is a period of "sweetness and light" which is characterized by the determination to achieve harmony at all costs. At this point the individuals have reached the beginning stages of problem- or group-centeredness. During the period of sweetness and light, the chains would become longer and overlap; the more complex structures would be retained but would become connected to other structures.

Stage 5. The sociogram would show greater complexity as the group becomes problem-centered.

Stage 6. The sociogram which would show complete integration would be one interlocked structure.

Preparation of Sociometric Data

To put the above criteria to test and to demonstrate its application, imaginary data for a sociometric test and re-test were set up. Procedure for arranging the data and for evaluating them according to the above criteria follow. First, the tabulation chart of choices is made, and on it the weighted acceptance scores are figured with 3 points for the first choice, 2 for the second, and 1 for the third choice (See Tables 1 and 2). The completed tabulation chart gives the number of times each chose, whom they chose, the acceptance scores of each, and the total number of choices used. By dividing the number in the group times the number of choices allowed into the number of choices used, the percentage of choices used is found.

The sociogram is then drawn as shown in Figures I and II. It reveals the number of reciprocated choices and the number of students receiving reciprocated choices. The percentage of mutual choices made by the class is found by dividing the total number of reciprocated choices occurring by the total number possible. Structural analysis shows the chains, triangles, squares, and isolated structures, and gives the over-all level of group growth.

TABLE 1
Tabulation Chart I
Test I

Choice	Ann	Betty	Carol	Dorothy	Enid	Frances	Greta	Helen	Irene	Janis	Kathie	Lois	Margie	Norma	Pat	Ruth	Choices Used
Ann	x							2		3	1			1		2	3
Betty		x														1	2
Carol	2		x							3						2	3
Dorothy				x		1									2		2
Enid			1		x					2						1	3
Frances						x			3								0
Greta							x							2			2
Helen	1							x		3						2	3
Irene						1			x				3			1	3
Janis						2				x	x	2					2
Kathie	1										2	x					3
Lois	1				3					1			x			3	3
Margie				2										x		2	2
Norma		1													x	2	3
Pat			1		3					1						x	3
Ruth	2					3											
1st	3	1	2	0	0	2	0	0	0	2	1	0	0	1	0	3	
2nd	2	0	0	1	0	1	0	1	0	1	1	1	0	1	1	5	
3rd	0	0	0	0	2	1	0	0	1	3	0	0	1	0	0	1	
Total	5	1	2	1	2	4	0	1	1	6	2	1	1	2	1	9	
Acceptance Score	13	3	6	2	2	9	0	2	1	11	5	2	1	5	2	20	

TABLE 2
Tabulation Chart II
Test II

Choice	Ann	Betty	Carol	Dorothy	Enid	Frances	Greta	Helen	Irene	Janis	Kathie	Lois	Margie	Norma	Pat	Ruth	Choices Used
Ann	x				1	2							3				3
Betty		x						2						1			2
Carol			x		2		3								1		3
Dorothy				x			2						1	3			3
Enid	1		3		x											2	3
Frances				2		x					1				3		3
Greta				3			x			1						2	3
Helen		2						x	1					3			3
Irene	3							1	x		2						3
Janis							2			x					3	1	3
Kathie	3					2					x					1	3
Lois												x					0
Margie				1						2			x	3			3
Norma		1		3									2	x			3
Pat			1				2			3					x		3
Ruth					2		3			1						x	3
1st	1	1	1	1	1	0	0	1	1	2	1	0	1	1	1	2	
2nd	0	1	0	1	2	2	3	1	0	1	1	0	1	0	0	2	
3rd	2	0	1	2	0	0	2	0	0	1	0	0	1	3	2	0	
Total	3	2	2	4	3	2	5	2	1	4	2	0	3	4	3	4	
Acceptance Score	5	5	4	7	7	4	8	5	3	9	5	0	6	6	5	10	

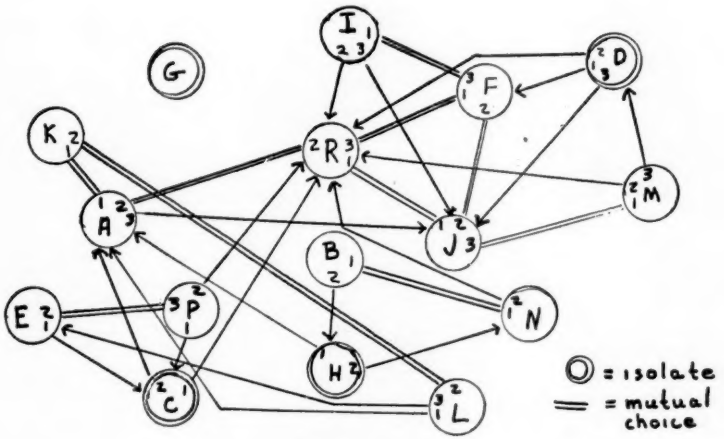


FIGURE I. Sociogram—Test I.

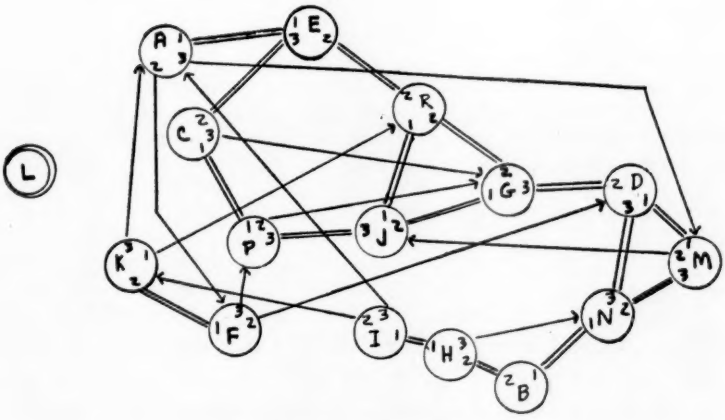


FIGURE II. Sociogram—Test II.

The next step is that of making the Rank Listing Chart as shown in Table 3 (1, *p. 415*). This chart reveals the range of scores on both tests, the stars and isolates, the gains and losses made by each individual; and gives a picture of the relative status and change of status of each individual in the group. In the beginning stages of group growth, the range on the first test will be broad and there will be a few overchosen to act as leaders. On the retest, the range

TABLE 3
Rank Listing Chart

Name	Acceptance Score Test I	Acceptance Score Test II	Gain-Loss	Test II* Rank Order
Ruth	20	10	L 10	10
Ann	13	5	L 8	9
Janis	11	9	L 2	8
Frances	9	4	L 5	7
Carol	6	4	L 2	7
Kathie	5	5	S	6
Norma	5	6	G 1	6
Betty	3	5	G 2	5
Dorothy	2	7	G 5	5
Helen	2	5	G 3	5
Lois	2	0	L 2	5
Pat	2	5	G 3	5
Enid	2	7	G 5	4
Irene	1	3	G 2	4
Margie	1	6	G 5	3
Greta	0	8	G 8	0

*The acceptance scores for Test II, shown in column 2 above, have been rearranged from highest to lowest number so that range of scores can be compared with those of Test I which appear in column 1 above.

should be decreased. The most chosen of the first test should have lost choices, and the least chosen should have gained them if the leadership and choices are shared. From this chart, data are readily available for plotting the acceptance curve—the next step. (See Figure III.)

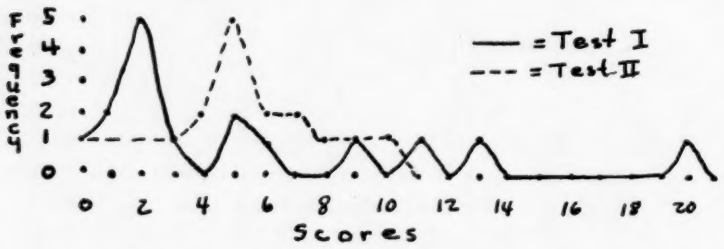


FIGURE III. Acceptance Curves.

The information provided by the charts, curves, and sociograms is now brought together in a summary chart. The summary chart for these data appears in Table 4. The items of this chart follow the criteria previously described.

TABLE 4
Summary Chart

Results	Test I	Test II
1. Isolates		
a. Number non-choosing	1	1
b. Number unchosen	1	1
c. Number without mutual choices	4	1
d. Total number of isolates	4	1
2. Percentage of mutual choices	41.52	66.67
a. Number of choices used	79.17	91.67
b. Number of persons having mutual choices	12	15
c. Total number of mutual choices	10	16
3. Number overchosen	2	0
4. Acceptance curve	J	normal
5. Structural analysis		
a. Chains	3 tangent to the triangle, with 3, 1, and 1 persons each	2 tangent chains of 1 and 3 persons each
b. Triangles	1	2
c. More complex	0	1
d. Closed structures	2 isolated pairs	1 isolated pair
6. Stage	2	5

Analysis of Sociometric Data

1. *Number of isolates.* The total number of isolates decreased. Greta was unchosen and chose no one on the first test but gained eight points on her acceptance score on the second. Lois lost her only choice and chose no one on the second test. She is also the only one who lost a reciprocated choice. This development is a warning signal for the teacher, and the reasons should be determined. Others with previous reciprocated choices still have them, although they may now be with different people. The four who previously had no reciprocated choices now do. On the whole, then, the group made real progress in group acceptance of all its members and improved in the ability of each member to form a common bond with others in the group.

2. *Reciprocated choices.* The total number of reciprocated choices possible for each test was 24 (one and one-half times the number in the group). On the first test there were ten mutual choices (41.52% of the total possible). On the second test, the number increased to 16 (66.67% of the total possible). This improvement was made possible, in part, by the increase from 79.17 to 91.67% in the number of choices used. The second factor causing the increase in the total number of reciprocated choices was that 15 rather than 12 students had mutual choices at the time of the second test. Because of the increase in the number of choices used, in the number of students receiving mutual choices, and in the number of reciprocated choices, the individuals and the group demonstrated growth according to criterion 2.

3. *Number of overchosen.* The acceptance score marking the overchosen has arbitrarily been set at twice the theoretical mean or above. Ruth and Ann both qualified as overchosen on the first test. They were the stars and leaders at the time the first test was given. On the second test there were no overchosen. This fact plus structural analysis of the sociogram indicates that leadership is now shared. Examination of the rank listing chart shows that the overchosen lost some of their choices and the least chosen gained. The class, therefore, would register a gain on this criterion.

4. *Acceptance curve.* The acceptance curve for the first test is similar to that for most sociometric data. It is a curve which is skewed to the right, indicating that a few students receive most of the choices. The curve for the second test is more nearly a normal curve with the node over the score of five. The curve has become more leptokurtic. All changes in the curve represent desirable group growth according to the criterion.

5. *Structural analysis.* Structural analysis of the sociogram for Test I revealed the level of growth to be at Stage 2, in that there are a number of mutual pairs and short chains. Ruth, Frances, and Jean formed a triangle with one and three person chains connected to each person of the triangle. This structure formed a good central core for development of over-all unity. The isolated pairs Betty-Norma and Enid-Pat and isolates Greta, Dorothy, Carol, and Helen (six of the 16 members of the class) needed to be brought into the group.

Analysis of the sociogram for the second test showed that the structure was more complicated and more highly differentiated. There is a six person subgroup, Enid-Ruth-Greta-Jean-Pat-Carol, which includes the triangle Ruth-Greta-Jean. A line from Greta to Dorothy connects this substructure with triangle Dorothy-Margie-Norma. Thus, the mutual choices of 13 of the 16 students form a well-connected and complex structure, which would place the group at Stage 5 in its development. Still to be brought into the group are the isolate Lois and the isolated pair, Kathie-Frances. On the whole the structural analysis revealed growth in group unity, inter-relatedness, and a good network of communication lines.

Had a teacher given these tests and obtained and analyzed these data, she would have evidence of the social growth of the individuals in the class, a knowledge of the students who were in need of special guidance, and a picture of the changes in group structure and unity. By comparing the data obtained against that of the theoretically ideal or perfect group, she could determine the position of her class in a way that is similar to the comparison of the mean archery score with that of a perfect round, or more realistically, with the highest recorded score ever made.

REFERENCES

1. American Association for Health, Physical Education, and Recreation. *Developing Democratic Human Relations*, Washington, D. C.: The Association, 1951, 562 pp.

2. BENNE, KENNETH D., and BOZIDAR MUNTYAN. *Human Relations in Curriculum Change.* New York: The Dryden Press, 1951. 363 pp.
3. BRONFENBRENNER, URIE, A constant frame of reference for sociometric research. *Sociometry,* **6**: 306-9, Nov. 1943.
4. CARTWRIGHT, DORWIN, and ALVIN ZANDER. *Group Dynamics.* Evanston, Ill.: Row, Peterson and Co., 1953. 642 pp.
5. CRISWELL, JOAN H., Notes on the constant frame of reference problem in sociometry. *Sociometry,* **13**: 93-107, May 1950.
6. FREEMAN, FRANK S. *Theory and Practice of Psychological Testing.* New York: Henry Holt and Co., 1950. 518 pp.
7. EDWARDS, DAISY STARKEY, The constant frame of reference problem in sociometery. *Sociometry,* **11**: 372-9, Nov. 1948.
8. JENNINGS, HELEN HALL. *Leadership and Isolation.* New York: Longmans, Green and Co., 1950. 240 pp.
9. ———, *Sociometry in Group Relations.* Washington: American Council on Education, 1948, 85 pp.
10. MORENO, J. L., *Who Shall Survive?* Washington: Nervous and Mental Disease Publishing Co., 1934. 440 pp.
11. ———, and HELEN HALL JENNINGS, Statistics of social configurations. *Sociometry,* **1**: 342-374, Jan. 1938.
12. NORTHWAY, MARY L., Personality and sociometric status. *Sociometry,* **9**: 233-241, May-August 1946.
13. ———, and BLOSSOM T. WIGDOR, Rorschach patterns related to the sociometric status of school children. *Sociometry,* **10**: 189-199, May 1947.
14. TODD, FRANCES, Sociometry in physical education. *Journal of Health, Physical Education, and Recreation,* **24**: 23-24 (Jan. 1953).
15. WHITSON, MILO EDWARD. *Statistical and Geometric Techniques for Sociometric Data.* Unpublished Doctoral dissertation, University of Southern California, Los Angeles, 1949. 233 pp.

(Submitted 8/11/55)

Age Differences and Inter-relationships Between Skill and Learning in Gross Motor Performance of Ten- and Fifteen-Year-Old Boys

FRANKLIN M. HENRY and GAYLORD A. NELSON
University of California
Berkeley, California

Abstract

The speed of performance of a sensory-motor skill is slower in 10-year-old than in 15-year-old boys, in both initial performance and in final performance after learning has reached a plateau. The younger boys improve more, have less task-specificity, and their individual differences in learning have a greater influence in determining final skill than is the case for the older boys. Within each age group, the amount of learning tends to be the same in similar tasks that differ in initial speed of performance. Fifty per cent or less of individual differences in motor learning are predictable from the pre-learning performance, and the direction of the relationship is negative, showing the futility of attempting to measure educability from performance level. Learning ability must be tested directly.

McGEOCH AND IRION, after reviewing the published research on changes in learning as a function of age, conclude that the rate increases during the first two decades of life (7, *p. 535*). Munn, on the other hand, interprets the evidence as showing that the amount of improvement that can be attained from practice is not systematically related to age (8, *p. 395*). These investigators have concerned themselves almost entirely with *verbal* rather than *motor* learning, because of the paucity of experimental studies in the latter area.

It is well known that motor skills are highly specific—appreciable intercorrelations between tasks occur only when there are obvious common elements. This topic has been reviewed by Lindeburg (6). There has been less attention to the question of whether *learning* as such is also characterized by a high degree of task specificity. Woodrow (10) found evidence that this is so, although the data available to him were mostly obtained with verbal material and his conclusions do not necessarily apply to motor problems. Heese (4) studied some of the so-called fine motor skills. Very low intercorrelations were found between individual differences in learning. There was one exception: Improvement scores in tracing a figure in the mirror-drawing test correlated $r = 0.57$ with improvement scores in tracing the same figure with a two-handed apparatus that controlled the movement of the pencil. Even though the common task element was substantial, the observed relationship

was not large since it accounted for only 33 per cent of the individual difference variance.

If gross motor skills are not completely specific, there is a possibility that the degree of specificity may be less in the younger individuals. Another question of interest is whether the ability to learn motor tasks is related to age within a range that is of particular interest with respect to physical education instruction in the schools. In addition there are several related problems, such as examination of the extent that it is possible to estimate motor educability from performance ability rather than directly from the learning scores. Stated in more fundamental terms, this is the problem of assaying the relative contribution of initial skill and amount of learning to individual differences in final skill attainment. It is too complex to be solved by simple examination of the correlation between performance and learning.

Methodology

One group of subjects ($n = 73$) included all boys in the tenth year of age from a small-town grammar school, with the exception of a few who did not complete the test because of illness or some other complication. Another group ($n = 72$) was a random sample of high school boys in their 15th year of age, from the high school of the same town.

The three motor tasks were chosen partly for their suitability with respect to the range of ages being investigated, and partly because they involved important basic elements of game skills. They were intentionally quite similar. One of them was very easy to perform. The subject held a celluloid ball in his hand next to his belt buckle, and responded to the stimulus by throwing this ball downward into a wastebasket and then reaching forward to grasp a tennis ball which was suspended in front of him at one-arm's-length distance. In this task the stimulus was a sound, and the response was simple, i.e., no stimulus discrimination or choice of movement was required. An electric chronograph measured the time required to respond to the stimulus by completing the forward arm movement.

The other two tasks were inter-related, involving the performance of one or the other of two movements in a visio-motor discrimination problem. This problem was unusual in that the perceptual discrimination was made as simple and unequivocal as possible through the use of multiple discrimination cues. Having discriminated and identified which stimulus had occurred, the subject performed the movement specified by that stimulus. The complete testing schedule required about one hour.

Apparatus. In front of the subject, and within his normal visual field, there were two corona glow lamps, an unmarked orange one and vertically below it a striped blue one. Also within the visual field, placed one arm's length away, were two colored balls hanging on strings. The upper one was orange; it was the larger. Below it was a blue striped ball. The task of the subject was to respond to the orange light by grasping the orange ball with a forehand movement, first dropping a table tennis paddle held in his hand. If the

lower (blue) light came on, the subject retained the paddle and used it to hit the lower (blue) ball with a backhand stroke. These movements were made from the standing position, with the hands and paddle touching the knees. One trial followed another at intervals of about 1 minute.

The strings supporting the balls were suspended by small metal strips held between spring contacts; if either ball was touched, the metal strip fell out immediately, opening the chronoscope circuit. This circuit was placed in action automatically by the same switch that turned on the stimulus light. In order to prevent undesirable swinging of the balls, their supporting strings passed downward to terminate at screw eyes attached to the floor of the device. The apparatus was very similar to one illustrated in certain other studies done at this laboratory (5), although the physical dimensions were about twice as large. An electric chronoscope measured the elapsed time from the first flash of the stimulus light to the completion of the motor response, with an accuracy of somewhat more than 0.01 sec.

A prepared randomized order was used to decide which stimulus (orange or blue) would be used in a particular trial, and whether the interval between the warning signal (a bell) and the stimulus light would be one, two, or three seconds. The same order sheet was used for all subjects. Timing of the foreperiod was controlled automatically by an electronic time-delay circuit. All subjects had at least 30 trials (15 forehand and 15 backhand) on this problem, and somewhat more than half of each group practiced 40 trials. Figure I will help to explain the procedure.

It will be seen that these two tasks had an identical element in common, namely the discrimination reaction time which has been found in subsequent (unpublished) studies to be about 0.35 sec. Approximately half of the measured performance time was therefore used for the reaction phase of the response and the other half was net movement time. Since only a single chronoscope was available, the motor performance scores included both reaction and movement times. The simple (non-discrimination) task described earlier was similar to the backhand task in that an object had to be released before proceeding with the principal movement, and was similar to the forehand task in that a forward arm movement was performed in order to grasp the ball. Only 40 per cent of the subjects in each age group were tested with the simple task, as the need for it was not recognized until the experiment had been in progress for some time.

In all three of these tasks there was no particular requirement for accuracy of response; speed was the factor emphasized to the subjects and measured by the apparatus. Motivation seemed to be high in both age groups. All the boys seemed interested in the tests and appeared to try to improve throughout the experiment. Naturally, the experimenter made every possible effort to keep the psychological factors constant. An additional degree of control was secured by testing an equal number of boys from each age group at any one

experimental period, so that any changes in effectiveness of instruction or seasonal influences would affect both groups.

Experimental Results

Age Differences in Mean Performance. Learning curves for the three tasks are shown in Figure I. In view of the irregularities of single trials (a typical

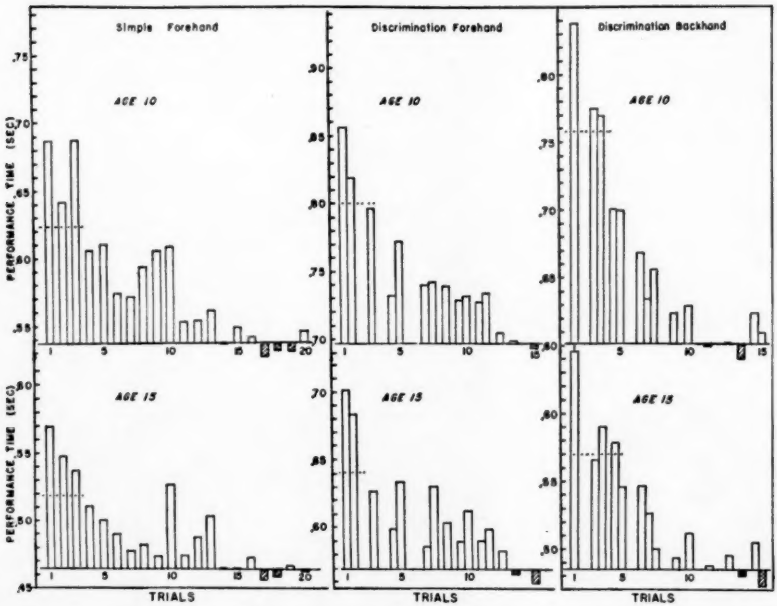


FIGURE I. Learning Curves. Between-trial spacing in the discrimination forehand and backhand tasks are arranged to show how the trials were interleaved, beginning with backhand trial one.

characteristic of learning curves in general) it has seemed desirable to average the first three trials as a measure of the initial performance level, and the last three trials as a measure of the final performance achieved. One is faced with a dilemma in this sort of situation—the reliability of the individual differences is increased as a large number of trials is used to define the measures, but at the same time the amount of learning (i.e., the differences between the initial and final measures) becomes less. One factor in the choice of three trials rather than some other number was the observation that, as will be explained later, a statistically significant improvement in performance can

just be demonstrated beginning with the fourth trial (for all three problems) if the initial performance is taken as the average of at least three trials.

Using these measures of initial and final performance, it may be seen in Table 1 that the younger subjects are definitely slower than the older boys at the beginning of each task. They are also slower at the end of the training period. The percent improvement due to the practice is not greatly different for the three tasks. Averaging all age groups and tasks, the percent gain is 18.4, ranging from 15.2 per cent for the older boys in the discrimination forehand problem to 24.2 per cent for the younger group for the backhand movement. The younger boys improve relatively more in all tasks—on the average, they gain 20.3 per cent in speed compared with only 16.5 per cent gain by the older boys.

TABLE 1

Descriptive Statistics for Two Age Groups in Three Motor-Learning Tasks

Statistic	Simple Forehand			Discrim. Forehand			Discrim. Backhand		
	Initial	Learn.	Final	Initial	Learn.	Final	Initial	Learn.	Final
M_{10}	0.672	0.135	0.537	0.842	0.145	0.697	0.794	0.192	0.602
M_{15}	0.552	0.088	0.464	0.671	0.102	0.569	0.594	0.109	0.485
Diff.	0.120	0.047	0.073	0.171	0.043	0.128	0.200	0.083	0.117
t	4.97	1.97	4.52	6.38	1.91	6.44	9.86	4.45	7.25
10 yr	*(n = 28)*			*(n = 73)*			*(n = 73)*		
σ	0.091	0.102	0.067	0.186	0.152	0.131	0.131	0.130	0.096
σ/M	0.135	——	0.125	0.221	——	0.188	0.165	——	0.159
r_{11}	0.530	0.396	0.744	0.814	0.678	0.684	0.566	0.394	0.572
15 yr	*(n = 29)*			*(n = 72)*			*(n = 72)*		
σ	0.095	0.072	0.085	0.130	0.110	0.104	0.111	0.089	0.097
σ/M	0.172	——	0.183	0.194	——	0.183	0.187	——	0.200
r_{11}	0.818	0.258	0.927	0.831	0.267	0.669	0.712	0.624	0.719

NOTE: The σ's for learning scores have been computed directly from the distributions. When computed indirectly from initial and final scores and the intercorrelation, there may be as much as 10 per cent discrepancy, presumably caused by cumulated grouping errors. Means are in seconds; individual instrumental error is negligible ($\sigma_e = 0.0035$ sec), influencing the average only 0.0005 sec.

The absolute amount of gain in speed by practice is greater in the younger age group for all three motor tasks. However, the advantage is statistically significant for only one, namely the backhand movement (t = 4.45). The absolute differences due to age are only about half as large as this in the other two tasks, and the t ratios are not quite significant—1.91 for the discrimination forehand task compared with 1.98 required for the 5-per-cent level of confidence, and 1.97 compared with 2.00 required for the simple forehand (the number of cases was smaller for the latter task).

Inter-Task Differences. In order to compare inter-task differences in learning, it seems reasonable to require that practice be continued until a stable plateau is reached. It is believed that this point was substantially reached in all three tasks as shown in Figure I. The two discrimination tasks are only shown to

trial 15 in this figure, since half of the subjects were not practiced beyond this point. In the 38 older subjects who had 20 trials in these tasks, the average of trials 18, 19, and 20 is 0.5 per cent slower than the average of trials 13, 14, and 15 for the discrimination forehand movement; the corresponding figure for the backhand is 2.4 per cent slower, so it may be said that learning did not progress after trial 15. In the 41 younger subjects who practiced 20 trials, there was a slight improvement in the forehand (1.0 per cent, $t = 1.53$) and also in the backhand (1.4 per cent, $t = 1.84$); it would seem that the learning was so nearly completed for these boys that the use of trials 13, 14, 15 as the final score is justified for most purposes. The slight additional gain would, however, be sufficient to cause the age difference in the discrimination forehand speed to be significant, since the estimated t ratio would be 2.00 compared with the previously non-significant value 1.91. In the case of the simple forehand movement, it is necessary to use the 20-trial learning period, because the gain between trials 13, 14, 15 and 18, 19, 20 is about 3 per cent, and is statistically significant in both age groups. However, the amount of gain from the last 5 trials is small, and it is doubtful if additional practice would have caused any important change.

It is rather curious that the amount of learning actually differs so little among the three tasks. As explained earlier, the inter-task differences in per cent improvement are not very large. Using the absolute gains, it is found that none of the mean differences in the older group are significant, since the inter-task t ratios are 0.44, 0.77, and 1.39. In the younger subjects, there is no important difference in the amount of learning as between the simple and discrimination forehand movements ($t = 0.52$), but the backhand learning is definitely greater than the simple forehand learning ($t = 2.76$) and also greater than the discrimination forehand learning ($t = 2.33$). All of the task averages differ significantly from each other in initial performance levels within the older subjects and within the younger subjects. The final performance means are in exactly the same rank order as the initial performances, and all inter-task differences are highly significant with a single exception—in the older group, the t ratio between backhand and simple forehand is only 1.42. The major differences between tasks, therefore, are in *performance level difficulty* rather than ease of learning.

INDIVIDUAL DIFFERENCES

Inter-Task Relationships. Even though the striking differences in average response are seen as characterizing initial and final response levels rather than amounts of learning, individual differences in ability persisting through the three tasks are more prevalent in the initial and final performances than in the learning phase. None of the inter-task correlations of amount of learning are significantly different from zero at the 1-per-cent level of confidence. In contrast, two-thirds of the possible inter-task correlations between performance levels have this degree of significance (Table 2).

TABLE 2

Inter-Task Correlations

Task	Type of Data	Age 10			Age 15		
		Initial	Learn.	Final	Initial	Learn.	Final
Simple forehand *vs.*	Raw	0.456	0.438	0.284	0.478	0.085	0.707
Discrim. forehand	Corrected	*0.694*	*0.838*	*0.438*	*0.580*	*0.322*	*0.869*
Simple forehand *vs.*	Raw	0.387	0.317	0.260	0.264	0.254	0.470
Discrim. Backhand	Corrected	*0.643*	*0.801*	*0.298*	*0.357*	*0.622*	*0.576*
Discrim. forehand *vs.*	Raw	0.551	0.276	0.434	0.503	0.122	0.583
Discrim. backhand	Corrected	*0.740*	*0.528*	*0.760*	*0.674*	*0.301*	*0.814*

NOTE: True-score intercorrelations (italics) have been corrected for attenuation in both variables (3, *p. 287*).

For more direct statistical evidence of this tendency, it is necessary to inspect the correlations between the discrimination forehand and the backhand movements, because this is the only inter-task comparison that involves a sizable sample of individuals (73 in the younger group and 72 in the older). The learning score intercorrelation is significantly lower than either initial or final performance correlations in the older group ($t = 2.61$ and 3.29). In the younger group, it is also lower than the initial score intercorrelation ($t = 2.03$), but not significantly lower than the final score intercorrelation ($t = 0.96$). The lower inter-task correlation for learning is intrinsic rather than just a reflection of lower reliability of learning scores, because when the inter-task correlations are corrected for attenuation in both variables (Table 2), the coefficient for learning remains significantly smaller than the coefficients for either initial or final scores, in both age groups.

Inter-task correlations are higher for the younger subjects in all cases insofar as learning is concerned, and are also higher in the case of initial scores. The age differences are not statistically significant. However, they are in consistent directions in all the inter-task comparisons using corrected coefficients and all but one using uncorrected coefficients, so there is a suggestion that there may be a genuine tendency for the younger subjects to have less task-specificity in learning these skills. Any such tendency has disappeared in the case of final skill level.

Regardless of any age tendencies, one cannot fail to be impressed with the high degree of task specificity. In examining this question, it must be remembered that the corrected correlation coefficients give the relation present after the removal of error variance, so that the square of a coefficient (multiplied by 100) gives directly the percentage of individual difference variance that is common to the performance (initial or final) or the learning of any two of the tasks. It will be recalled that a considerable amount of similar elements were incorporated in these tasks; even so, the correlations are far from high. Evidently the learning of motor tasks, at least those of the type

used in this experiment, is not a matter of motor-learning ability—rather, it is a matter of specific aptitudes for learning specific tasks.

Individual Differences at Final Skill Level. As practice progresses, improvement follows a law of diminishing return until the learning curve approaches either an asymptote or at least a line of very little slope. It is important to know whether individual differences tend to disappear in this region, or whether they persist at full effect. One way of estimation is to use the size of the standard deviation as an index of the degree of individual differences, although it must be recognized that it is made up of two components—true individual difference variance and error variance. Also, the individual difference variance (in contrast to error variance) is not necessarily independent of the mean. For this reason, the coefficient of relative variation ($V = 100\ \sigma/M$) is sometimes used. The size of the reliability coefficient is probably a better index than either.

It can be seen by inspection of Table 1 that the standard deviation is somewhat smaller in the final performance as compared with the initial performance. The coefficient V changes very little. When the tasks are averaged, there is a 9.4 per cent drop in V in the younger group, and a 2.4 per cent rise in the older boys. The average reliability coefficient rises 4.7 per cent in the younger group and declines 1.9 per cent in the older group. Since these changes are small and inconsistent, it seems likely that the extent of individual differences does not change from the initial performance level to the final level.

Within-Task Correlations. If one defines motor educability as ability to learn, it may be inferred from the pattern of intra-task correlations (Table 3) that performance scores cannot be substituted for improvement scores in the assaying of individual differences in *educability*. The pattern is somewhat different in the two age groups, but there are certain features common to both. Individual differences in amount of learning are negatively related to degree of initial skill—slow performers have greater possibilities for improvement, and they do indeed tend to improve more than those with a higher degree of initial skill. In other words, a *good* initial score indicates *poor* educability.[1] The coefficient of determination (3, p. 223), however, averages only 40 per cent for the older boys and 52 per cent for the younger group, so the predictibility is certainly not high.

[1]The term "motor educability" is commonly used to mean *ability to learn motor skills easily;* sometimes the definition is *ability to develop a high degree of skill quickly* (2), thus implying the involvement of motor skill capacity (i.e., the ability to reach a high final score as learning approaches completion). Presence of a substantial negative correlation would seem to require the acceptance of the latter, more complex, definition. In another article a "W" score is developed in order to meet this definition of educability and to provide a means of escaping the dilemma imposed by the negative relationship. See Henry, F. M., Evaluation of motor learning when performance levels are heterogeneous, *Research Quarterly* **27**: 176-181, 1956.

TABLE 3

Within-Task Correlations

Task	Score	Age 10		Age 15	
		Learning	Final	Learning	Final
Simple forehand	Initial	−0.747	0.266	−0.618	0.758
	Learning		0.437		0.008
Discrim. forehand	Initial	−0.714	0.460	−0.722	0.656
	Learning		0.280		0.009
Discrim. backhand	Initial	−0.712	0.406	−0.551	0.583
	Learning		0.326		0.315

NOTE: In this table the measures have been treated as speed scores rather than time scores, so that the negative relation between initial performance and learning will be seen clearly.

In the older subjects, the tendency is just about equally great for boys who start in a certain relative position to end in the same relative position as it is for boys who start with a poor initial score to improve more than those who start with a high score. In other words, the correlation of individual differences in initial score is as large with final score as it is with amount of learning. In the younger boys, the situation is somewhat different; the coefficients involving initial score give only about half as large a correlation with final score as with learning, and the differences in correlation are statistically significant for each of the three motor tasks ($t = 2.32$, 2.67 and 2.48).

A point of view of more practical interest is the final performance attainment. One may ask how important *is* learning as a determiner of individual differences in the completely learned performance. For the backhand movement, the coefficients relating learning to final score, while low, are significant at the 1 per-cent level of confidence for both age groups. (Incidentally, the reliabilities of scores in this task tend to run somewhat *lower* than in the other two.) As the correlations are negative in sign, the relationship is in the direction of large improvement being associated with fast performance in the final tests. In the other two tasks the same pattern is evident for the younger subjects, but the coefficients are smaller and only pass the significance test at the 5-per-cent level of confidence. In the older subjects the corresponding correlations are zero; amount of learning is unrelated to final performance level in either the simple or the discrimination backhand movements. It seems that individual differences in learning are subject to both age and task influences in their extent of determination of final attainment.

It may be noted that the systems of intra-task correlations are internally consistent within each task and for each age group. As a test of this, all of the partial correlations have been computed, and are found to fall within the range $r = 0.93$ to 0.99. Therefore, one may with some confidence compute the beta coefficients and by utilizing their products with the associated correlation coefficients (3, *p. 261*) estimate the per cent contribution of individual

differences in initial score and learning as factors determining individual differences in the final performance level in each task. This has been done in Table 4. The multiple *R*'s are also shown in the Table. Since they are all close to unity, it is evident that the intra-task correlations require no correction for attenuation (this would be expected, since the learning scores are fully determined by initial and final score magnitudes).

TABLE 4

Relative Contribution (in per cent) of Individual Differences in Initial Score and Learning to Final Score

Task	Age 10			Age 15		
	Initial	Learning	R	Initial	Learning	R
Simple forehand	35.6	62.7	0.992	93.6	0.6	0.971
Discrim. forehand	62.0	34.8	0.984	90.8	1.1	0.958
Discrim. backhand	52.4	40.6	0.965	63.3	28.7	0.960

NOTE: The relative contributions have been computed as the products of the beta coefficients with the corresponding r's (3, *p. 261*).

Age Differences in Effects of Learning. It is evident from this analysis that initial scores are in general more important than the amounts of learning in determining individual differences in the final level of skill. There is one exception; in the simple forehand response, learning is more important than initial score in determining the final score. Learning exerts a much larger influence in the younger subjects than in the older boys—in fact, the learning plays a negligible role in two of the three tasks for the 15-year-olds and is less important in the remaining movement than it is for any of the three in the 10-year-olds. This does not mean in any sense that the older subjects do not learn—rather, it means that *individual differences* in learning are small as compared with the individual differences in initial performance in the older subjects. It will be recalled that the evidence in Table 1 showed that the amount of learning was highly significant in both age groups, and the mean differences in amount of learning in the two age groups was only of borderline statistical significance in the very tasks in which the most striking differences are now found with respect to the relative contribution of individual differences. This is an example of the necessity of supplementing analysis of mean differences by correlational analysis in order to understand the role of individual differences.

AGE DIFFERENCES IN LEARNING RATE

With respect to age differences in rate of learning, it was shown in Table 1 that there is a definite tendency for the younger subjects to improve somewhat more than the older boys, when both age groups receive the same amount of practice. This does not necessarily mean that the *rate* of learning is faster in the younger group. For example, if one asks how many trials are required to secure a single trial mean performance that differs by a statistically significant amount (at the 5-per-cent level of confidence) from the cumulated

average score up to that point, it turns out that three trials are required for the simple forehand response in each age group, as shown by the broken lines in Figure I. In the discrimination problem, two forehand trials are required, with no age difference. The backhand response yields somewhat equivocal results because of irregularities in the curve of the older subjects, but a smooth curve through the graph would indicate three trials are required for them, which is the same as the requirement for the young group in this task.

Attempts to fit a mathematical curve system to these graphs in order to quantify the learning rates with greater accuracy has not been fully satisfactory due to the irregularity of the points. The impression gained through these attempts is that there is little if any age difference in rate of learning. Cozens (1) found that a parabolic equation of the form $Y = X^2$ described the improvement due to a semester of practice in such events as the dash, half-mile run, broad jump, discus, etc. Of course, this improvement was due to athletic training as well as learning, and the equation may not be theoretically correct for true learning curves. It is found that a general form of the parabola does describe the learning in the present experiment quite as well as certain other formulae that were tried (as for example, an exponential equation). The equation used is $y = at^{-k}$ where y is the time required to perform the motor act, a is the initial performance, t is the number of practice trials, and k is the rate coefficient. The mathematical curves have been drawn in Figure II, using a log-by-log graph so that the parabolic curves will plot as straight lines having slopes proportional to the rate coefficient.

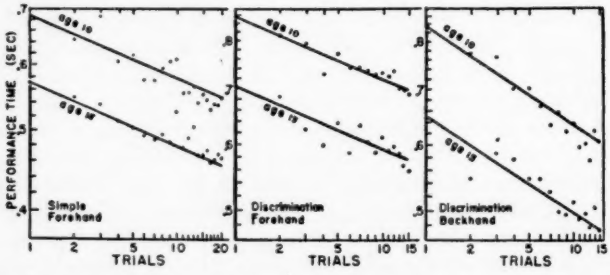


FIGURE II. Parabolic Learning Curves. Use of logarithmic co-ordinates results in a straight-line plot of the equation $y = at^{-k}$.

It is rather interesting that the same rate coefficient ($k = 0.076$) seems correct for both the simple and the discrimination forehand movement data, whereas the backhand movement requires a considerably larger coefficient ($k = 0.117$). Identical rate coefficients have been used in both age groups. Inspection of the figure suggests that the learning progresses slightly faster in the younger age group, since the points tend to fall below the line for them in the later part of the learning period, but the difference is small.

Discussion

It would seem that the position of Munn (8), rather than McGeoch and Irion (7), is substantiated by these data. If the rate of motor learning changes with age, it tends to become *slower* rather than faster in the older subjects. Any possible difference in rate is, however, not impressive in the present experiment. There is more consistent evidence that the *amount* of learning is greater in the younger group. While small in comparison with the large age differences in initial and final performance levels, it seems to be definitely present and contradictory to the general expectations of McGeoch and Irion.

The finding of moderately high correlations, negativ in sense, between amount of learning and initial amount of skill, is quite different from the intra-task relationships observed by Woodrow (9) for problems in which the motor-learning component was small or absent. He reported low correlations ranging between $r = 0.24$ and -0.05 between initial scores and learning in digit substitution performed by 82 subjects, whereas his correlations between learning and final score for these tasks ranged from $r = 0.75$ to 0.82. In the present experiment, the comparable correlations are quite small, and several are zero, although they are positive in sense (*i.e.*, the large learning scores are associated with fast performance in the final test). The other problem for which he made this type of analysis was horizontal adding (essentially a mental task); in this case the relation between learning and final score was very high, $r = 0.93$. It seems very likely that the inter-relationships may be quite different in motor and non-motor learning.

In the Heese study of fine motor skills (4), the only intra-task correlations reported are those between initial and final scores. The coefficients found for his 50 subjects range from $r = 0.25$ for maze tracing to 0.55 for mirror tracing and 0.65 for the typing test. These results are similar to those obtained in the present study.

With respect to task specificity of motor learning, the results obtained by Heese on the precision type of fine motor skills are confirmed for an entirely different type of response using gross motor movements of a non-precise type. There is, however, suggestive evidence that the degree of specificity of the latter type of response may be somewhat less in the younger subjects.

The evidence presented to illustrate the danger of the confusing motor *educability* with *ability* (the former being necessarily identified with ability to learn and the latter with performance level) agrees with certain conclusions of Gire and Espenschade (2). While these investigators did not compare individual differences in learning with differences in performance level in the same task, as was done in the present experiment, they did fail to find any consistent or substantial correlation between non-learning tests purporting to measure motor educability and the actual amounts of motor learning in several activities. It should also be mentioned that Woodrow (10) has been fully cognizant of the hazards of confounding performance level with

learning. He has shown that certain types of widely used learning scores such as total errors or total successes in the practice period are uninterpretable because, even though correlated with learning, they may be correlated even more highly with performance level. The latter *may* in some cases be strongly influenced by prior learning, but on the other hand it may not be, and there are certainly other factors that are always operative in determining its magnitude.

It seems appropriate to comment on the infrequency of studies of learning in the physical education research literature. Only slightly more than 2 per cent of the articles published to date in the *Research Quarterly* have been concerned with this topic to the extent that an index entry has resulted, and in most of the instances the concern with learning has only been incidental. The nature of motor learning, the factors that influence its progress favorably or unfavorably, the amount of practice required to secure a specified amount of improvement; the location of plateaus in typical motor skills and the methods by which further learning can be accomplished, outline only a few of the problems that await solution in this relatively inactive field.

Summary and Conclusions

Seventy-three boys age 10 years and 72 boys age 15 learned a sensory-motor problem involving stimulus discrimination and choice of a forehand or backhand movement depending on the stimulus. Forty per cent of the boys also learned a non-discrimination problem utilizing similar movements but a different stimulus.

The younger boys averaged 22 per cent slower than the older ones in initial performance for the simple motor task; in the discrimination tasks they were 25 and 33 per cent slower. Their amount of learning was greater than that observed in the older group, although this age difference was considerably less significant, statistically, than was the case for initial and final performance scores. Age differences in *rate* of learning, estimated from a parabolic learning curve, were negligible. Inter-task differences in amount of learning were small, even though initial and final performance scores were considerably different in the three tasks.

The correlations between individual differences in the performance of the three tasks were not high, even when corrected for attenuation in both variables. Inter-task correlations of amount of learning and also of individual differences in initial skill were larger in the younger boys, suggesting that the relative specificity of motor learning increases between ages 10 and 15 years.

Individual differences in final performance of the two forehand movements were almost entirely determined, and backhand speed was 63 per cent determined, by *initial amount of skill* rather than by *learning* in the older age group. In contrast, *learning* was an important determiner (35 to 41%) of final performance of the younger boys in the discrimination tasks and

accounted for 63 per cent of individual differences in final skill in the simple forehand response. Approximately 50 per cent of individual differences in learning in the younger boys and 40 per cent in the older group were predicted by the initial performance scores, but the sense of the relationship was negative rather than positive, indicating the futility of measuring motor educability by using performance scores without including direct estimates of learning aptitude. The intra-task relationships were quite different from those reported by others for non-motor tasks such as addition.

Evidently, the 10-year-old differs from the 15-year-old in being slower in motor performance of the type measured. On the average, he learns more than the older boy before the plateau is reached, but probably approaches the plateau at the same rate. His final skill is more determined by his ability to learn than is characteristic of the 15-year-old. Individual differences in the final skill of the latter are chiefly determined by initial skill. Even among gross motor tasks that are similar, task-specificity is great; it tends, however, to be less in the younger boy. Individual differences in final score are relatively as great as in initial performance, although this conclusion must be qualified by consideration of the possibility that learning was not yet completed for some individuals in this experiment, even though it was substantially completed for the average.

REFERENCES

1. Cozens, F. W. A curve for devising scoring tables in physical education. *Research Quarterly*, **2**(4) : 67-74, 1931.
2. Gire, Eugenia and Anna Espenschade. The relationship between measures of motor educability and the learning of specific motor skills. *Research Quarterly*, **13**: 43-56, 1942.
3. Guilford, J. P. *Fundamental Statistics in Psychology and Education.* New York: McGraw-Hill, 1942.
4. Heese, K. W. A general factor in improvement with practice. *Psychometrika*, **7**: 213-223, 1942.
5. Howell, M. L. Influence of emotional tension on speed of reaction and movement. *Research Quarterly*, **24**: 22-32, 1953.
6. Lindeburg, F. A. A study of the degree of transfer between quickening exercises and other co-ordinated movements. *Research Quarterly*, **20**: 180-194, 1949.
7. McGeoch, J. A. and A. L. Irion. *The Psychology of Human Learning.* New York: Longmans, Green and Co., 1952.
8. Munn, N. L. Learning in children. In: Carmicheal, L. (Ed), *Manual of Child Psychology.* New York: Wiley, 1954.
9. Woodrow, H. Factors in improvement with practice. *Jour. Psychol.*, **7**: 55-70, 1939.
10. Woodrow, H. The ability to learn. *Psychol. Rev.* **53**: 147-158, 1946.

(Submitted 7/28/55)

Evaluation of Motor Learning When Performance Levels Are Heterogeneous

FRANKLIN M. HENRY
University of California
Berkeley, California

Abstract

In three motor learning experiments (jumping, speed of arm movement and balancing), raw learning scores are unrelated to final degree of skill but are negatively correlated with initial performance. Using the method of residuals to hold statistically constant the influence of initial skill, it is possible to compute derived learning scores which are unrelated to initial skill and at the same time substantially correlated with learning and also with post-learning performance. Since these scores estimate the individual learning that would have occurred if each person had started at the same level of initial skill, they should prove practically useful as true measures of motor educability. The method can readily be applied to the construction of tabular norms in which several variables must be taken into account. It has also been used to define an endurance index.

THE TERM PHYSICAL EDUCATION presupposes a concern with instruction; the effectiveness of instruction is necessarily evaluated in terms of improvement in skill or knowledge on the part of the learner. As a matter of convenience, the attained performance level is often assumed to be proportional to the amount of learning, but this assumption is frequently deceptive because of the high correlation between pre-instructional and post-instructional performance levels (3) and the extremely variable correlation between improvement and either initial or final skill (6, 10).

These facts have led some investigators to an insistence that learning must be evaluated strictly in terms of improvement that is due to instruction and practice (9, 11). While this dogma appears necessary in certain types of research analysis, it does not follow that it leads to a logical evaluation of individual differences in learning in all research or in a practical teaching situation—indeed, the very presence of substantial correlations between amount of learning so defined and performance level proves it to be illogical in the latter frame of reference. One obvious method to avoid the dilemma is to use some kind of percentage score in order to relate learning to performance level. While this method has received considerable use (7, 8), it has been severely criticized by Woodrow (11) and can be shown to have additional theoretical objections (1, 2).[1]

[1]McCraw, in an article published since this was written, has discussed several types of learning scores and has listed additional references. See *Research Quarterly*, **26**: 440-453, 1955.

Method

The desired learning score is one that shows a minimum correlation with initial performance level and at the same time a maximum correlation with amount of improvement. Ratio scores (e.g. percentage improvement scores) do not achieve this end (2); neither do simple subtractive scores (1). The fundamental problem of method is similar to that involved in computing the "residual" type of endurance index in running (4). Using an algebraic simplification of the formula that the writer has presented elsewhere for that purpose (5, *p. 463*), with the symbol W representing the desired score we may write

$$W = Y - bX + C \qquad [1]$$

where Y is the individual's learning score, X is his pre-learning performance level, $b = r_{xy}\sigma_y/\sigma_x$ and $C = bM_x$.

The score W may be called the *attainment score.* It specifies how much the individual learner has improved (in raw score units), after a correction for whatever advantage (or disadvantage) in learning he may have received by starting the learning process at a level that was higher or lower than average. Since the correction has been computed from the regression equation that predicts amount of learning from the pre-learning performance, the formula yields the net amount of learning when individual differences in the factor X are held statistically constant.

Limiting Conditions. While the attainment score has a minimum correlation with the pre-learning performance, this correlation is not necessarily zero —it may retain a finite positive magnitude. The degree to which it can approach zero is limited by the consistency requirement that the partial correlation between W and X, with Y held constant, cannot exceed unity. It results from this that the nearest it can be to zero is determined by the boundary magnitude $r_{wy}\,r_{xy} - k_{wy}\,k_{xy}$ where k is the coefficient of alienation. If r_{wy} and r_{xy} are equal to or less than 0.707, the magnitude of r_{wx} can be zero; if they have conjugate values such as 0.80 and 0.60 or 0.90 and 0.44 or 0.95 and 0.31 it can also be zero. If they are larger, r_{wx} must be greater than zero—for example when they are both 0.80 it must be 0.28 or larger; when they are both 0.90 it must be 0.62 or larger; when one is 0.80 and the other 0.90 it must be 0.46 or larger, etc. Usually, however, the correlation r_{wx} will be close to zero.

Results

Learning to Jump. Sixty college men were given seven consecutive trials in vertical jumping, using the Sargent technique with a simplified "leap-meter" to expedite measurement. There was no preliminary practice. Rests of approximately two minutes were allowed between trials. Amount of learning, estimated as the amount of improvement from trial 1 to trial 7, was highly significant ($t = 9.8$).

The mean performance in these trials, and the standard deviations, are given in Table 1. This information, together with the correlation coefficient relating the improvement to the initial performance level ($r_{xy} = -0.599$) has

been substituted in the formula in order to compute the *W* scores. Various intercorrelations are also shown in the table; these will be discussed later.

TABLE 1

Mean Scores and Intercorrelations in Jumping Test
(Height Jumped in inches)

Factor	Attainment (*W*)	Initial (*X*)	Learning (*Y*)	Final (*Z*)
M	1.74	18.11	1.73	19.48
σ	1.015	2.40	1.35	2.04
r_x	0.165	———	−0.599	0.827
r_y	0.593	−0.599	———	−0.044
r_z	0.668	0.827	−0.044	———

Learning an Arm Movement. Thirty college men were given 16 consecutive trials on a speed-of-movement apparatus. The subject rested his index finger on a reaction key. In response to an auditory signal he moved his hand upward and to the right 12 inches to knock down a tennis ball suspended on a string, then downward and to the left 18 inches to press a push button, and finally upward and forward to knock down a second tennis ball. An electric chronoscope recorded the time from the beginning of the first movement to the completion of the last. Reaction time was *not* included in the score.

Since single trials are not very reliable for data of this kind, initial performance level was taken as the average of the first three trials and final performance level was taken as the average of the last three. Improvement was of course the difference between these two averages. The performance data, *W* score, and intercorrelations are given in Table 2. Improvement was highly significant ($t = 12.1$).

TABLE 2

Mean Scores and Intercorrelations in Arm Movement Test
(Time in seconds)

Factor	Attainment (*W*)	Initial (*X*)	Learning (*Y*)	Final (*Z*)
M	0.173	0.644	0.179	0.464
σ	0.0605	0.103	0.080	0.070
r_x	0.130	———	0.677	0.630
r_y	0.682	0.677	———	−0.138
r_z	−0.586	0.630	−0.138	———

Learning to Balance. Forty-six college men were given five consecutive practice periods on a pivoted balance platform (stabilometer). The subject stood on the platform in the erect position; his task was to learn to keep it approximately level, engaging in a minimum of movement. Degree of success was measured in arbitrary units of stabilometer movement, by means of a graphic recorder attached to the platform. Each trial consisted of 30 seconds of *net* exposure, not counting time during that part of any period that the

subject was so far out of balance that the platform was held against the end-stops. Rest periods of two minutes were given between trials. Learning, defined as the improvement between initial and final trials, was highly significant ($t = 10.4$). The results are given in Table 3.

TABLE 3

Mean Scores and Intercorrelations in Balancing Test

(Platform and movement in arbitrary units)

Measure	Attainment (W)	Initial (X)	Learning (Y)	Final (Z)
M	12.4	41.8	12.5	29.3
σ	5.26	14.03	8.05	8.65
r_x	−0.144	———	0.729	0.850
r_y	0.469	0.729	———	0.267
r_z	−0.579	0.850	0.267	———

Discussion

In all three sets of data there are found substantial negative correlations ($r = 0.60$, 0.68 and 0.73) between initial performance ability and amount of improvement. These correlations carry a positive sign in Experiments 2 and 3 because of the type of scoring, but the relation is negative in direction because poor performers, i.e., those who moved slowly in hitting the balls or those who moved the balance platform a great deal in their attempts to achieve balance, were the individuals who made the largest improvement. Even so, they still scored poorly in final skill, so it would be illogical to consider their motor educability as high.

Amounts of improvement show approximately zero relationship with final degree of skill in Experiments 1 and 2 ($r = 0.04$ and 0.14); this correlation is somewhat larger in Experiment 3, but is too small to be statistically significant. One would therefore gain the erroneous impression from this conventional type of analysis that the learning experience had made no contribution to individual differences in the final degree of skill achievement.

In decided contrast, the W scores show substantial correlations with learning ($r = 0.59$, 0.68 and 0.47) and also with final skill ($r = 0.67$, 0.59 and 0.58); thus they meet the two criteria of true *motor educability* measurement (6). The signs are consistent in signifying that those who tend to improve a *relatively* large amount, considering their initial level of skill, tend to achieve a high final performance. There is of course an additional factor involved in the final skill attainment, namely the tendency for individuals who are most skillful in the initial test to maintain their position of high skill in the final test.

The operation of these two factors can be understood more readily if the final performance Z is considered a criterion, to be predicted by the initial performance X and the adjusted attainment W. In the case of Experiment 1, the resulting multiple correlation is $R = 0.99$. The relative contribution of the two factors, estimated by the usual beta coefficient method, is 62 per cent from initial skill X and 38 per cent from learning attainment W. In Experiment 2, initial skill contributes 53 per cent and W contributes 47 per cent;

$R = 0.925$. In Experiment 3 the initial skill is a more preponderant factor, contributing 71 per cent to a multiple R of 0.97 as compared with only 29 per cent contribution from W.

In the light of these results, it would appear that the use of the statistical correction furnished by the residual method is just as important in evaluating learning as it is in evaluating endurance. Individual differences in learning can be fairly treated, even though the initial performance level is heterogeneous. Since the W scores represent the best possible linear statistical estimate of what the individual learning scores would have been if all subjects had been of equal proficiency at the start of the learning period, they should be of considerable practical utility.

Care must be taken to insure that grouping errors are small, otherwise the weighting coefficient b may be so inaccurate that the correlation $r_{w\bar{x}}$ is not zero. It is possible to make an empirical correction to b in such a situation. An increase of 3 or 4 per cent in b in the first two experiments, or a decrease of 3 per cent in the third, would have resulted in $r_{w\bar{x}}$ being more exactly zero. Evidently some degree of skewness of distribution can be tolerated — the scores in Experiment 3, for example, were positively skewed—but extreme skewness will probably cause trouble.

Application to Tabular Norms

It will sometimes be desirable for administrative convenience to tabulate a series of norms, ordered with respect to the initial performance ability X. To do this, the correlation $r_{\bar{x}y}$ may be used to predict the mean normal improvement Y' from a spaced series of X values, using the regression equation

$$Y' = bX - C + My \qquad [2]$$

where the coefficients b and C have the same meaning as before. Table 4 gives a set of such norms computed from the three sets of data. If desired, **T** scores could be calculated for each of the X categories, using as a base the

TABLE 4

Learning Norms for Heterogeneous Initial Skill

Jumping (*Inches*)		Arm Movement (*Seconds*)		Balancing (*Movement*)	
Initial (X)	Norm (Y')	Initial (X)	Norm (Y')	Initial (X)	Norm (Y')
21	0.76	0.90	0.313	70	24.3
20	1.09	0.80	0.261	60	20.1
19	1.43	0.70	0.209	50	15.9
18	1.77	0.60	0.156	40	11.8
17	2.10	0.50	0.100	30	7.6
16	2.44	0.40	0.051	20	3.4

partial standard deviation $\sigma_{y.\bar{x}} = \sigma_y k_{xy}$. One should however be hesitant in placing too much reliance on a set of **T** scores computed in this manner—they would be dependable throughout the range, only to the extent that the assumptions of normal curve statistics have been met. The mean norms are relatively insensitive in this respect, the chief concern having to do with

linearity of regression. It should be mentioned that both of the equations can be adapted to the purpose of holding more than one variable statistically constant, by including the appropriate partial regression terms.

Summary and Conclusions

Three motor learning experiments are described, one in which 60 subjects showed a marked improvement in vertical jumping during the course of seven trials, a second in which the speed of performing a complicated arm movement increased greatly in 30 subjects as a result of 16 practice trials, and a third in which a large amount of learning in the skill of balancing was observed in 46 subjects during five practice trials.

Correlations were fairly high ($r = 0.63$ to 0.85) between initial and final degrees of skill. Raw learning scores were negatively correlated with initial skill ($r = 0.60$ to 0.73), but had no significant relation with final attainment ($r = 0.04$ to 0.27).

By holding statistically constant the influence of individual differences in initial skill, it was possible to compute a set of corrected learning scores that exhibited approximately zero relationship with initial skill. These derived scores were found to have substantial correlations with raw learning scores ($r = 0.58$) and also with final skill attainment ($r = 0.61$). They are therefore unique in offering valid measurement of motor educability in terms of both aspects of its definition.

The statistical method developed was found to be similar to the "residual" technique of estimating individual differences in endurance. Practical applications were discussed, including the problem of setting up tables of norms and the possibility of holding several variables statistically constant.

REFERENCES

1. Cogan, E. A. The problem of simple combination scores in measurement. *Am. Psychol.*, **10**: 461, 1955.
2. Du Bois, P. H. On the statistics of ratios. *Am. Psychol.*, **3**: 309, 1948.
3. Heese, K. W. A general factor in improvement with practice. *Psychometrika*, **7**: 213-223, 1942.
4. Henry, F. M. and D. A. Farmer. Condition ratings and endurance measures. *Research Quarterly*, **20**: 126-133, 1949.
5. Henry, F. M. *et al.* Errors in measurement. In: *Research Methods Applied to Health, Physical Education and Recreation.* Washington, D. C.: AAHPER, 1949.
6. Henry, F. M. and G. A. Nelson. Age differences and inter-relationships between skill and learning in ten- and fifteen-year-old boys. *Research Quarterly*, **27**: 162-175, 1956.
7. McCraw, L. W. A factor analysis of motor learning. *Research Quarterly*, **20**: 316-335, 1949.
8. McGeoch, J. A. and A. L. Irion. *The Psychology of Human Learning.* New York: Longmans, Green and Co., 1952.
9. Woodrow, H. The relation between abilities and improvement with practice. *J. Educ. Psychol.*, **29**: 215-230, 1938.
10. ———. Factors in improvement with practice. *Jour. Psychol.*, **7**: 55-70, 1939.
11. ———. The ability to learn. *Psychol. Rev.*, **53**: 147-158, 1946.

(Submitted 9/27/55)

Influence of Puberal Development on Responses to Motivated Exercise

BIRGER L. JOHNSON
Fresno State College
Fresno, California

Abstract

Junior high school boys, classified into stages of pre-pubescent, pubescent, and post-pubescent development, performed two exercise trials on a bicycle ergometer, one trial motivated by personal urging and encouragement and the other trial non-motivated. Response to exercise and motivation was observed in terms of work output and cardiovascular adjustment. Significant differences in work output were found between the puberal groups, but the differences between the motivated and non-motivated trials were not significant. Cardiovascular recovery from exercise was hindered by motivation; also nausea was a frequent occurence following the motivated trial but not following the non-motivated trial.

THE ROLE OF physical exercise and sports activities in promoting physical development is well recognized. However, the effects of exercise under highly motivated conditions such as is found in organized competition among junior high school boys has been questioned (2, *p. 89;* 13, *p. 194;* 30, *p. 17*). The degree of puberal development appears to be an influencing factor in the responses of a growing boy to exercise and to emotional stimulation.

Problem

In this study, the acute responses of pre-pubescent, pubescent and post-pubescent boys to motivated and non-motivated exercise has been investigated. Specifically, the study attempted to determine the differences in work output and cardiovascular adjustment between motivated and non-motivated exercise for each of three puberal groups and also the differences between the groups under each of the two exercise conditions. The relationship of nausea to work output and motivation was also observed.

Procedure

The subjects in this investigation were 59 junior high school boys 12 to 13 years of age. All subjects were given physical examinations by a school physician prior to the experimental tests and were classified by him as pre-pubescents, pubescents, or post-pubescents according to Crampton's Pubic Hair Criteria (10). There were 25 boys in the pre-pubescent classification, 19 in the pubescent classification, and 15 in the post-pubescent classification.

The exercise consisted of pedaling a bicycle ergometer at maximum effort against a fixed resistance of five pounds. This resistance was such as to allow

every boy to pedal as rapidly as he was able. Each of two trials, one motivated and the other non-motivated, was broken up into eight bouts of work each lasting for 30 seconds, and the work bouts were separated by rest periods of 30 seconds duration. This procedure of intermittent exercising was selected to simulate actual competitive conditions which so often are characterized by stop and go tactics and sudden bursts of speed which last for only a brief period of time.

The responses to exercise were measured in terms of work output as recorded in foot pounds by the bicycle ergometer, and cardiovascular adjustments as measured by changes in heart rate and blood pressure during and following each exercise trial. Heart rates were counted by palpation or auscultatory technique using a mercurial sphygmomanometer. The arrangement of the experimental apparatus is shown in Figure I.

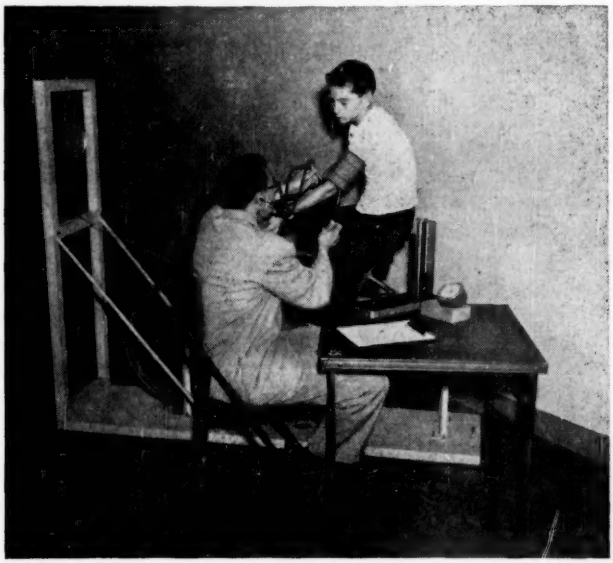


FIGURE I. Arrangement of Subject, Investigator, and Apparatus During Experimental Exercise Trial.

The methods selected for motivating the subject during the motivated trial were the establishment of a competitive situation prior to exercise and the use of personal urging and encouragement during the exercise trial. Before starting the motivated trial the subject was told he was competing against his schoolmates and also against boys from a rival school. During the motivated trial he was continually encouraged to work at maximal effort. Prior to the

non-motivated trial the subject was instructed to pedal as fast as possible but he then was permitted to perform the exercise in the absence of any kind of encouragement.

Work output data and cardiovascular findings were treated statistically using the analysis of variance technique and Fisher's t-test. The F-test was used initially to determine whether or not statistically significant differences existed (a) between the means of the two trials for each of the three puberal groups, and (b) between the means of the puberal groups for each of the two experimental exercise trials. If a statistically significant F was found with this procedure, Fisher's t-test was applied to the data. The t-test for correlated means was used in analyzing the means of the differences between the exercise trials for each puberal group, and the t-test for non-correlated means was used to analyze the differences between the means of the three puberal groups. The 5-per-cent level of confidence was accepted as indicating statistically significant differences.

Recovery blood pressures were not studied statistically because the individual fluctuations were so great that systematic analysis was not feasible. However, recovery blood pressures, recorded observations, and the subjects' reactions to the tests were reviewed in analyzing the data relating to the nausea cases and to the adjustments of the subjects to motivated and non-motivated exercise conditions.

Discussion of Results

RELATIONSHIP OF SIZE AND PHYSIOLOGIC MATURITY TO PHYSICAL PERFORMANCE

The findings showed that the factors of height and weight were related to physiological maturity. Table 1 shows that, on the average, pubescent boys were taller and heavier than pre-pubescent boys, and the mean height and

TABLE 1
Height and Weight for Three Puberal Groups

Group	Height		Weight	
	Mean	Range	Mean	Range
Pre-pubescents	59.20	55.50-62.75	87.26	66.00-113.00
Pubescents	60.77	57.25-65.50	101.04	78.00-147.00
Post-pubescents	63.51	58.50-67.75	116.30	100.00-143.00

NOTE: Height in inches, weight in pounds

weight of post-pubescent boys was greater than either of the other two puberal groups. However, the heights and weights of individuals in all three puberal groups fell within the over-all range. The mean height of post-pubescent boys was about four and one-third inches greater than pre-pubescent boys and their mean weight was about 29 pounds heavier than the pre-pubescent group. These figures correspond closely to Dimock's (11) figures of 14-year-old boys which showed that the post-pubescent boy exceeded the pre-pubescent boy in height by four and one-half inches and in weight by 33 pounds.

The findings of this investigation in relation to physical performance appear to confirm the observations of McCloy (23), Dimock (11), Jones (17), and Keithly (19), in that post-pubescent boys are, on the average, capable of greater physical performance than are boys in the earlier stages of pubescence. In this study, post-pubescent boys performed a significantly greater amount of work than either of the other two puberal groups, but there was no statistically significant difference between the mean work output of pubescent and pre-pubescent subjects (Table 2).

TABLE 2
Differences in Work Output Between Puberal Groups

Group	$Mean_1$	$Mean_2$	Mean Difference	t	Level of Confidence
Non-Motivated					
Pre-pub.—Pub.	279.89	298.72	18.83	1.737	Not Sig.
Pre-pub.—Post-pub.	279.89	322.47	42.58	3.403	1%
Pub.—Post-pub.	298.72	322.47	23.75	2.004	5%
Motivated					
Pre-pub.—Pub.	285.00	305.44	20.44	1.885	Not Sig.
Pre-pub.—Post-pub.	285.00	331.87	46.87	3.698	1%
Pub.—Post-pub.	305.44	331.87	26.43	2.234	5%

NOTE: $Mean_1$ refers to mean of puberal group first designated, $Mean_2$ to group designated second. Figures are in 100-ft.-lb.

Post-pubescent boys were larger, on the average, than either of the other two puberal groups, and there is a positive correlation between work output and physical size. However, pubescent subjects as a group, while physically larger than pre-pubescent subjects, did not perform a significantly greater amount of work. Moreover, it was observed that the greatest amount of work was not performed by the tallest or heaviest boy nor was the least amount of work performed by the shortest or lightest boy. The greatest amounts of work were performed by boys who had an athletic-type build and were post-pubescent. This agrees with Jones' (17) observation that early maturing boys were more likely to be mesomorphs, probably more athletic, and on the average, superior in strength to the late maturing.

The foregoing statements would seem to indicate that, under the conditions of this investigation, the superiority of post-pubescent subjects in performing work is partly the result of greater size, and, in addition, is probably also due to some factor of maturation present to a greater degree in post-puberty than pre-puberty.

RESPONSES OF PUBERAL GROUPS UNDER MOTIVATED AND NON-MOTIVATED EXERCISE CONDITIONS

Work Output. Individual differences in emotional reactivity are observed to produce the considerable variability of response to specific emotional stimuli. Many observers (4; 17, *p. 39;* 21, *p. 464;* 25, *p. 218*) have noted that personal encouragement has had a beneficial effect on improving performance, especially in the field of athletic sports. On the other hand, certain kinds of emotional stimuli have been shown (20, *p. 236*) to produce negative

effects on performance (e.g., razzing), or even the energizing influence of encouragement may serve to diminish performance in some competitors, especially if applied at the wrong time (18, *p. 39*; 25, *p. 218*).

In this investigation, motivation consisted of establishing a competitive situation prior to the motivated trial, and during the exercise trial the performer was continually encouraged to work at a maximum pace. The results of the experiments showed that the effect of personal urging and encouragement was not the same for all individuals as far as work output was concerned; some subjects increased their work output under motivation, whereas others performed less work. None of the puberal groups showed a mean increase in work output in the motivated trial over the non-motivated trial that was statistically significant (Table 3).

TABLE 3
Comparisons Between Motivated and Non-Motivated Trials

Condition	Mean Motivated	Mean Non-Motivated	Mean Difference	t	Level of Confidence
Work Output					
Pre-pubescents	285.00	279.89	5.11	1.01	
Pubescents	305.44	298.72	6.72	.761	
Post-pubescents	331.87	322.47	9.40	1.21	
Maximum Systolic P.					
Pre-pubescents	128.63	136.26	7.63	3.61	1%
Pubescents	140.56	140.08	.48	1.24	
Post-pubescents	151.60	152.27	.67	.294	
Maximum Heart Rate					
Pre-pubescents	186.58	183.16	3.42		
Pubescents	182.40	182.20	.20		
Post-pubescents	183.33	187.00	3.67		

NOTE: Work output is in 100 ft-pds., heart rate in beats per minute and blood pressure in mm. of mercury. Low F values for maximum heart rate did not justify solving for t.

The failure of some subjects to increase their work output under motivated conditions cannot be explained with sureness. There was no doubt that these subjects were stimulated by the urging and encouragement they received while exercising. The stimulating effect of motivation was evidenced by an increased heart rate and an attempt to increase their pace when verbally encouraged to do so. However, some factor seemed to be operating which prevented them from producing a net work load greater than that which they produced without any exhortation.

It is possible that the urging and encouragement the subjects received while pedaling the ergometer served to overstimulate them to the point that increased tonus in the antagonistic muscles inhibited rapid muscular movement and made it impossible for them to attain maximum speed. Measurements of muscular tension were not made in this study. However, tension reaction to motivation was observed by Morehouse and Cooper (25, *p. 218*) with experienced players in athletic sports who became overstimulated and experienced sensations they referred to as "tying up," or "choke."

Another possible reason for the failure of the subjects to improve their performance under motivation was the factor of pacing. There was little doubt that many of the subjects, when encouraged to do so, increased their pace to a maximum speed which they were unable to maintain for the entire work bout. This had the effect of fatiguing many of them so extremely that they could keep going toward the end of the experimental run only with very intense effort. Some of the subjects during the non-motivated run set a pace that was submaximal but one which they could maintain for a longer time at a higher average work load for the entire exercise period. This resulted in greater total work output under non-motivated conditions for these well-paced subjects.

For many of the subjects, urging and encouragement was not overstimulating but served to keep them working at a rapid pace which decreased in non-motivated runs as they began to tire. These subjects performed more total work under motivated conditions.

Cardiovascular Responses. In this study the average resting heart rates for the three puberal groups ranged from 71.07 to 75.37 beats per min. and the average resting systolic blood pressure from 106.05 to 119.73 mm. Hg. (see Table 4). Systolic blood pressure values at rest compare closely with those of other investigators (5, 7, 24, 33). The mean heart rates of the boys in this study were somewhat lower. In this study the resting heart rates were taken after the subject had sat quietly on a chair for from five to ten minutes.

TABLE 4

Heart Rates and Blood Pressures Before Exercise

Cardiovascular Response	Mean Trial I	Mean Trial II
Resting Heart Rate		
Pre-pubescents	75.21	75.37
Pubescents	72.24	74.40
Post-pubescents	71.87	71.07
Resting Systolic Pressure		
Pre-pubescents	106.05	106.89
Pubescents	111.12	110.28
Post-pubescents	119.73	116.87

NOTE: Heart rates are in beats per min.; systolic blood pressures in mm. of mercury.

During exercise, maximum heart rates up to 210 beats per min. were observed. The average maximum rates for the three puberal groups under motivated and non-motivated conditions are shown in Table 3. Other investigators working with comparable age groups have reported maximum heart rates up to 204 beats per minute (6, *p. 27*) and 193 beats per min. (29), and average maximum heart rates during strenuous exercise of 195 beats per min. (12) and 182.6 beats per min. (6). The extreme high heart rates obtained in this study are indicative of the intensity with which the work was performed.

Mean maximum systolic blood pressures during non-motivated exercise showed an increase of about 30 mm. Hg. above resting levels for pre-pubescent subjects and an increase of about 35 mm. Hg. for post-pubescent subjects (see Table 3). These values compare closely to those of Seham and Egerer-Seham (29) who observed an average rise in blood pressure during exercise of from 35 to 41 mm. Hg. for children between nine and 15 years of age. Diastolic pressures were not recorded during exercise.

It would seem reasonable to expect that the heart rate during motivated exercise with its accompanying emotional excitement would be higher than during non-motivated exercise. Whitehorn and others (35) found that moderate exercise increased the heart rate from about 80 to over 120 beats per minute and that an emotional disturbance increased it even further. This was not found to be the case in this study, however. Maximum heart rates and blood pressures were not significantly different between motivated and non-motivated exercise for the pubescent and post-pubescent groups, and pre-pubescents had a lower mean heart rate during motivated exercise (Table 3). This may be explained by the nature of the exercise, which was very strenuous, in some cases even exhaustive. The upper limits of heart rate were attained by most subjects even during non-motivated exercise so that motivation was unable to effect a further increment.

In Table 3, it is shown that the pre-pubescent group also had a significantly lower mean maximum blood pressure during the motivated run. It is difficult to explain the lower blood pressure during the motivated trial. It is known that in some cases of severe anxiety the over-all peripheral resistance is decreased with a subsequent fall in arterial pressure. Pre-pubescent subjects, as a group, were somewhat more excited and apprehensive than the other two groups. It is possible that the additional excitatory stimulation of urging and encouragement during motivated exercise was such as to effect an over-all decrease in vascular tone. The factors producing a fall in arterial blood pressure possibly operated to a greater extent under conditions of intense anxiety, such as was often present during motivated exercise conditions. This reaction has been suggested by Hickam and co-workers (14).

A more noticeable manifestation of the effects of motivated effort on heart rate and blood pressure was observed during the recovery period following cessation of exercise. Each puberal group showed a significantly higher heart rate following motivated exercise than following non-motivated exercise (F equalled 5.06, 36.97 and 61.29 for the pre-pubescent, pubescent, and post-pubescent groups, respectively, all significant at the 1-per-cent level of confidence), and, in many cases, the recovery curve of blood pressure was far more erratic following the motivated run.

Nausea During Recovery. One of the most significant findings of this investigation was that emotional excitation, or stimulation, did not cause subjects, on the average, to perform a greater amount of work, but in many cases it did cause a serious alteration in their circulatory adjustment. This

was manifested in the condition of nausea which developed in many of the subjects either during the exercise or during the recovery period following the motivated trial. The appearance of nausea in subjects with lesser blood pressure elevations during motivated exercise supports the concept that these subjects may have experienced severe anxiety. A rather important observation was the fact that out of a total of 22 cases of nausea—37 per cent of the total number of subjects and representing all three puberal groups—there was only one case of nausea during recovery following non-motivated exercise. All the other cases of nausea occurred during or after the motivated run.

When the subjects who developed nausea during recovery or during exercise were compared with those boys who did not become nauseated, some striking observations were noted. A natural assumption might be that the subjects became nauseated because they performed a greater amount of work under motivated conditions. This was not generally the case, however. Table 5 shows that the group which developed nausea performed less work during the motivated trial than they did during the non-motivated trial, while the group which did not develop nausea during the motivated trial performed more work during this trial. The mean difference in work output between the two trials for the nausea group and the non-nausea group was shown to be significant at the 1-per-cent level of confidence (see Table 5). This observation emphasizes a very significant characteristic of young boys near the age of puberty, that is, their extreme individual variability. In this investigation it was found that for some boys motivation served as a helpful stimulus to increased work output, a stimulus well within their emotional tolerance. For other boys, of the same chronological age and physiological development, this same motivational factor served as a detrimental emotional stimulus which induced a lower working efficiency and so upset the body homeostasis that recovery was erratic and sickness resulted.

TABLE 5

Comparison of Work Output Between Nausea Group and Non-Nausea Group

Group	No.	Net difference in work output	Mean difference in work output	Standard Deviation
Nausea group	21	−24,411.00	−1,162.43	3,626.3
Non-nausea group	38	+62,241.00	+1,637.92	1,942.3
$t = 3.795$ significant at the 1% level for 57 d.f.				

NOTE: Differences in work output are expressions of increases or decreases in motivated exercise compared to non-motivated exercise. The t is an expression of mean differences in work output between the nausea group and the non-nausea group. Figures are in ft.-lb.

Values for systolic and diastolic pressures during recovery fluctuated too greatly to allow statistical treatment but they were valuable in analyzing circulatory adjustments during this period. The recovery curves of heart rate and blood pressure for cases who developed nausea showed more marked fluctuations than those of cases who did not become nauseated. This was especially true of blood pressure curves. A close inspection of the recovery blood pressure was extremely helpful in dealing with nausea cases. A sharp

drop of systolic pressure to low levels and a corresponding rise in diastolic pressure was nearly prognostic of developing nausea. The curves of systolic and diastolic pressure were noted to converge as nausea developed. This is nicely illustrated by Case #36 in Figure II. As this condition developed, vomiting was usually allayed by having the subject sit with his head down between his knees. When vomiting did occur, it was usually within the first or second minute post-exercise. These cases were the most difficult to detect

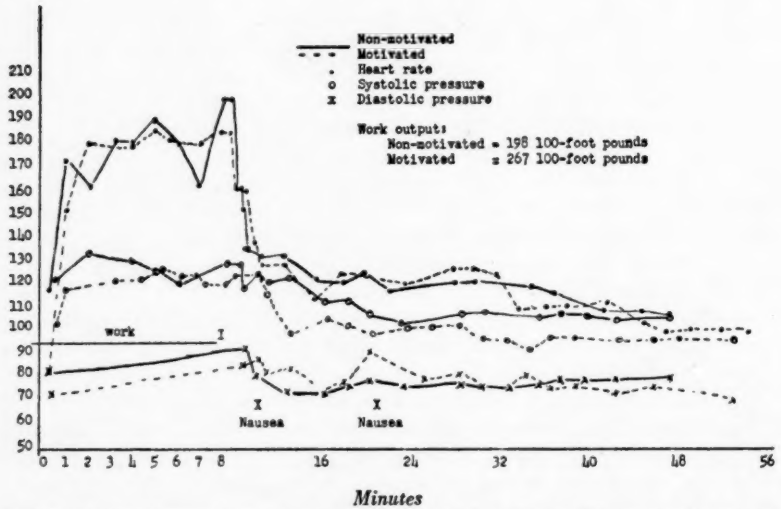


FIGURE II. Heart Rate and Blood Pressure Curves for Case No. 36. Figures on the vertical scale are heart beats per minute and millimeters of mercury.

as acute changes in blood pressure were often masked by otherwise normal pressure responses induced by the abrupt cessation of exercise. When nausea occurred early, i.e., within the first or second minute post-exercise, recovery usually continued in a normal manner comparable to cases where nausea was not present. Vomiting was always accompanied by acute sickness and great distress. However, almost without exception, the subject felt much better immediately after vomiting and within a very short time there was no evidence of his having been sick. In no case did the sickness persist or show any untoward effects. The condition was likely akin to a kind of "sports sickness" described by Steinhaus (32) which occurs frequently in athletes following strenuous exertion in sports contests. Jokl (16) has described the condition as a harmless functional disorder to which no unfavorable prognostic significance could be attached.

The precise cause of nausea during and following motivated exercise is not known. Steinhaus stated it is in some way related to a shortness of oxygen and to a rapid drop in blood sugar. However, Karpovich (15, *p. 250*) found that with young men who experienced indisposition following short bouts of strenuous exertion on a bicycle ergometer, the blood sugar level was normal, in some of them even elevated. He suggested that the indisposition experienced by some after strenuous exercise is the result of cerebral disturbance caused by an excess of lactic acid in the blood. Seham and Egerer-Seham (29) observed the sudden drop of systolic blood pressure preceding nausea and noted that the subjective signs simulated those of shock. They suggested this might be the result of sudden anemia of the brain.

Hyperventilation has been suggested as a cause of nausea following motivated exercise. This has the effect of "blowing off" carbon dioxide which causes the vasoconstricting center to relax the tone of the splanchnic vessels. When these vessels dilate, the blood pressure is caused to fall.

Whatever the precise cause of nausea, it appears certain in this study that it was associated with a sudden fall in blood pressure. Because this fall occurred more frequently following motivated exercise, it appears likely that it is of vasomotor origin produced probably by an imbalance of autonomic nervous function. Such a condition has been suggested by Arnold (3). Dilation of splanchnic vessels and orthostatic hypotension are probably the immediate causes of the fall in systolic blood pressure. This is suggested by the fact that the condition of nausea was alleviated greatly by having the subject assume a semi-horizontal sitting position with the head placed low between the knees. This position eliminates the resistance of gravity and favors venous blood flow to the heart.

Conclusions

Observations in this study support the following conclusions:

1. The reactions of adolescent boys in junior high school to exercise performed under motivated conditions are extremely variable. Boys of the same age, body size, and maturational development may differ greatly in their responses to personal urging as motivation to greater effort while performing strenuous exercise.

2. When 12- and 13-year-old boys are performing strenuous exercise, additional motivation in the form of personal urging and exhortation tends to produce greater effort, as evidenced by increases in pace and more acute adjustments in heart and blood pressures, but this additional effort does not necessarily produce greater total work output.

3. Some boys are able to augment their work output when urged and exhorted to do so, while others show decreased work output under these conditions, and this decrease may be followed by adverse physiological effects of which nausea is the most obvious symptom. Both responses occur among boys in each puberal stage.

REFERENCES

1. American Association of School Administrators. *Health in Schools—20th Yearbook.* Washington, D. C.: National Education Association, 1942.
2. Anderson, M. S., and A. B. Bowyer. The effects of basketball on junior high school boys. *West Virginia Medical Journal,* **35:** 89-91, 1939.
3. Arnold, Magda B. Physiological differentiation of emotional states. *Psychological Review,* **52:** 35-48, January, 1945.
4. Basler, Vance E. *The Effect of Cheering on Total Work Output.* Unpublished Master's thesis, University of Southern California, Los Angeles, 1948.
5. Begg, Foster A. *A Comparative Study of the Extreme Reactions of the Heart as Recorded by the Cardiotachometer for a Controlled Group of Twenty-Eight Boys.* Unpublished Master's thesis, New York University, 1930.
6. Boas, Ernst P., and Ernst F. Goldschmidt. *The Heart Rate.* Springfield: Charles G. Thomas, 1932.
7. Braun, Genevieve L. Pulse rate reaction of children to graded exercise. *Research Quarterly,* **13:** 78-86, March 1942.
8. Brinley, Eldon D. Interschool athletics for elementary school youngsters. *Journal of School Health,* **23:** 209-213, Sept. 1953.
9. Chapman, J. Crosby, and R. B. Feder. The effect of external incentive on improvement. *Journal of Educational Psychology,* **8:** 469-474, Oct. 1918.
10. Crampton, C. Ward. Physiological age—A fundamental principle, *American Physical Education Review,* **13:** 141-154, March 1908.
11. Dimock, Hedley S. A research in adolescence. Part I. Pubescence and Physical Growth. *Child Development,* **6:** 177-195, Sept. 1935.
12. Gallagher, J. R. and Lucien Brouha. Dynamic physical fitness in adolescence. *Yale Journal of Biology and Medicine,* **15:** 659-679, May 1943.
13. Hall, Caroll C. Basketball can be harmful. *Hygeia,* **24:** 194, March 1946.
14. Hickam, J. B., W. H. Cargill, and Abner Golden. Cardio-vascular reactions to emotional stimulus. Effect on the cardiac output, arteriovenous oxygen differences, arterial pressure, and peripheral resistance. *Journal of Clinical Investigation,* **27:** 290-298, March 1948.
15. Joint Committee on Athletic Competition for Children of Elementary and Junior High School Age. *Desirable Athletic Competition for Children.* Washington: American Association for Health, Physical Education and Recreation, 1952.
16. Jokl, E. On indisposition after running. *Research Quarterly,* **12:** 3-11, March 1941.
17. Jones, Harold E. Motor performance and growth. A developmental study of static dynamometric strength. *University of California Publications in Child Development,* I, **1:** 1-182, University of California Press, Berkeley and Los Angeles, 1949.
18. Karpovich, Peter V. *Physiology of Muscular Activity.* Philadelphia: W. G. Saunders Co., 1953.
19. Keithly, Bowlen B. *The Relationship Between Physiological Age and Motor and Physical Development.* Unpublished Master's thesis, University of Iowa, Iowa City, 1929.
20. Laird, Donald A. Changes in motor control and individual variations under the influence of exercise. *Journal of Experimental Psychology,* **6:** 236-246, June 1923.
21. Law, Frank W. Some clinical aspects of muscular exercise. *Quarterly Journal of Medicine,* **22:** 461-475, April 1929.
22. Lowman, Charles L. The vulnerable age. *Journal of Health, Physical Education, and Recreation,* **18:** 635-636, Nov. 1947.
23. McCloy, C. H. Appraising physical status: Methods and norms. *University of Iowa Studies in Child Welfare,* **15:** 89-98, 1938.
24. McCurdy, J. H. Adolescent changes in the heart rate and blood pressure. *American Physical Education Review,* **15:** 421-432, June 1910.

25. Morehouse, Laurence E., and John M. Cooper. *Kinesiology*. St. Louis: C. V. Mosby Co., 1950.
26. National Committee on School Health Policies. Suggested School Health Policies. *Journal of Health, Physical Education, and Recreation*, **17**: 144-146, March 1946.
27. Recommendations from the Seattle Convention Workshops. *Journal of Health, Physical Education and Recreation*, **18**: 429-432, Sept. 1947.
28. Schneider, E. C., and C. R. Crampton. The respiratory responses of pre-adolescent boys to muscular activity. *American Journal of Physiology*, **117**: 577-586, Dec. 1936.
29. Seham, Max and Grete Egerer-Seham. Physiology of exercise in childhood—Part I. A study of normal children of school age. *American Journal of Diseases of Children*, **25**: 1-45, Jan. 1923.
30. Shock, N. W. *Physiological Studies of Adolescence*. Berkeley: Institute of Child Welfare, University of California, 1936.
31. Society of State Directors of Physical and Health Education. The public school program in health, physical education, and recreation. *Journal of Health, Physical Education, and Recreation*, **10**: 435-439, Oct. 1939.
32. Steinhaus, Arthur H. Facts and fancies about exercise. *Physical Education and Healthful Living*, Edited by L. M. Fraley, W. B. Johnson, and B. M. Massey. New York: Prentice-Hall, Inc., 1954. p. 93.
33. Sutliff, W. D. and Evelyn Holt. The age curve of pulse rate under basal conditions. *Archives of Internal Medicine*, **35**: 224-251, Feb. 1925.
34. Wegner, F. R. What age for high school athletes. *Scholastic Coach*, **5**: 11-12, April 1936.
35. Whitehorn, J. C., M. R. Kaufman, and J. M. Thomas. Heart rate in relation to emotional disturbance. *Archives of Neurology and Psychiatry*, **31**: 712-731, April 1935.

(Submitted 10/24/55)

Comparative Analysis of Items of Interest in Marriage and Parenthood of 4,000 Students in Junior and Senior Colleges

JOSEPH E. LANTAGNE
University of California
Santa Barbara, California

Abstract

This is a study of the result of some 4,000 inventories being administered to students in eight junior colleges and 13 senior colleges and universities. There was a sampling of 2,000 men and 2,000 women. The inventory included 60 items which were prepared by the author after several years of review, experimentation, and then modified by several authorities in this field.

The purpose of this study was to determine the interests in the various areas for marriage education. The results of the study indicate the differences in interests of both sexes for lower and upper division students. The results can be used as a guide to deter- to determine course content.

TODAY, AS NEVER BEFORE, there is an ever-increasing demand for an intelligent approach to successful marriage. The increasing number of articles, publications, and amount of research devoted to this topic indicates an increased public awareness of the importance of this area. Educational institutions must now assume a more positive role in preparing youth for the responsiblities and privileges of marriage.

Not only must educational institutions prepare youth for marriage, but they must help youth meet the problems of marriage. In a recent issue of *Life*,[1] a discussion of the married student revealed that the number of married undergraduate men and women is on the increase. From this study, it appears that more than 10 per cent of the undergraduates attending coeducational colleges are married. Continued dependence on one or both families, responsibilities of parenthood, and the necessity for both working and studying may bring more than the usual number of stresses and strains to the student marriage.

Fortunately, institutions of higher learning are modifying their curricula to meet the needs and interests of today's youth. Many colleges and universities now include the area of marriage and parenthood as an integral part

[1]Ernest Haveman, "To Love, Honor, Obey, and Study," *Life*, **38**: 21, May 23, 1955, pp. 152-166.

of a broad general education program. However, it is the belief of the author that this area is not receiving enough emphasis.

"A recent survey reported over 500 colleges and universities in this country giving courses on family relations. These vary in content and method, but their trend in the past 25 years has been away from preoccupation with the role of the family as an institution toward an increasing emphasis on preparation for marriage and the interpersonal relations of husband and wife, and parents and children. A measure of the practical nature of such courses is the types of problems spontaneously brought by the students to the instructor for consultation. These relate to every phase of the physical and emotional aspects of marriage."[2] Dr. Bowman states, "There is no doubt the need for marriage education and the student's interest in it. Nor is there any doubt that marriage education on the collegiate level is here to stay. Sooner or later, most schools which profess to meet the student needs in education for life will incorporate marriage education in the curriculum."[3]

The problem in developing an adequate school curriculum is determining the needs and interests of the students. It is evident that this information can be best obtained from the students themselves. This study is an attempt to ascertain the items of interest of college students in order to better plan, organize, and present a course in marriage and parenthood that is significant and meaningful to the students. The needs of students must also be considered. The connotation of interest as it is to be used in this study is defined to be "the conscious feeling of concernment in an object, regarded especially as a stimulant and guide to the arousement and direction of attention."[4]

Procedure

The interest inventory that was used in this study was planned, developed, and directed by the author. The inventory was purposely limited to 60 items for ease of administration. These items were selected after a review of many textbooks and periodicals related to this field, and after a number of course outlines from leading colleges and universities had been carefully scrutinized. The items were also reviewed and screened by several leaders in the marriage field who offered suggestions and some modifications.

Eight California junior colleges and 13 senior colleges and universities contributed to the administration of the 4,000 inventories. Location of these colleges varied from large metropolitan areas to small cities with a more rural

---

[2]Abraham Stone, M.D. "Historical Backgrounds—Marriage Education and Marriage Counseling in the United States," *Marriage and Family Living*, **11**: 2, spring, 1949, National Council of Family Relations, Menasha, Wis., p. 38.

[3]A. Henry Bowman, "Education for marriage—By-Product or Objective," *College and University*, **27**: 2, Jan. 1952, p. 259.

[4]Funk & Wagnalls, *New "Standard" Dictionary of the English Language*, New York and London: Funk & Wagnalls Co., 1947, p. 1279.

type population. Colleges that were known to have interested personnel to administer the inventories were chosen in order to assure reasonable student participation. Inventories were taken anonymously.

Interest inventories of 2,000 women and 2,000 men students were used in this study. These inventories were equally divided between junior and senior college students. This assured a reasonable sampling of junior and senior college students and materially simplified the computations of the study.

Analysis of Data

The raw data was transferred to International Business Machine scoring cards. These cards were machine tabulated which served to minimize the possibility of human error. An analysis of all items was made to determine items of greatest interest and items of least interest. Items of interest were then tabulated according to sex, religion, and year in college.

Validity and Reliability

Validity was established by utilizing items most frequently mentioned in current textbooks and magazine articles in this field, as well as those in my "marriage and parenthood" courses over a period of years.

Reliability was established by the following:

1. Correlations of .83 and .87 between test and retest with two junior college groups.
2. Using the split-half method on 100 inventories a .93 correlation was obtained in the junior college group.
3. A correlation of .87 was obtained by comparing the 2,000 junior college students to the 2,000 senior college students.
4. A correlation of .75 was obtained when comparing the 25 items of greatest interest of 1,000 junior college women with that of 1,000 senior college women.
5. A correlation of .80 was obtained when comparing the 25 items of greatest interest of 1,000 junior college men and those of 1,000 senior college men.

Related Studies

There have been a number of studies that relate to the use of student interests in the content of college courses. Several studies summarized by Henry Bowman,[5] James Gladden,[6] and a committee report on Education for Marriage and Family Relations in Southern Colleges,[7] add to the necessity for more

[5]A. Henry Bowman, "The Content of a Functional Marriage Course," *College and University*, **27**: 3, April 1952, pp. 355-364.

[6]W. James Gladden, "Research-Oriented Teaching of the Course in the Family," *Social Forces*, **32**: 1, Oct. 1953, pp. 56-60.

[7]Committee on the Teaching of Sociology of the Southern Sociological Society; "Education for Marriage and Family Relations in Southern Colleges," *Social Forces*, **32**: 1, Oct. 1953, pp. 61-65.

research in curriculum development. Laurence Bee[8] used a series of attitude scales as projective media to study basic personality characteristics of students for improvement of a course of study. Other studies have made contributions; however, these results have usually been concerned with rather specific topics.

Analysis of Data

A detailed item analysis of the relative interest in the 60 problems used in this study may be found in Table 1. This table indicates the percentage of response to each item. There was considerable variance in the degree of indicated interest which ranged from a 67 per cent response to the item of greatest interest—Parent-Child Relationships—to an 18 per cent response to the topic of least interest—Chronic and Degenerative Diseases.

The second and third items of greatest interest were Normal Sex Relations and Happiness with the Home and Family with 65 per cent and 64 per cent responses, respectively.

The fourth and fifth items of greatest interest were Mental Adjustments in Marriage and Religion and Marriage, with responses of 61 per cent and 59 per cent. These items are considered by all authorities in the field of marriage counseling as significant; however, the difference of interest among religous beliefs is insignificant.

The sixth item of interest was Pregnancy Problems with a 58 per cent response. The items Living with the Opposite Sex, Wholesome Attitude Toward Marriage, Responsibilities of Parents, Demands of the Opposite Sex, and Juvenile Delinquency all clustered around 57 per cent. In another study by the author of 10,000 secondary students, Juvenile Delinqency received a 60 per cent response.[9] This clearly indicates that juvenile delinquency is of considerable concern to both high school and college students.

Other important items of interest were The Family as a Unit, A College Education, Birth Control Problems, and Marriage While in College. Items concerning similar subjects seem to cluster together in either the high or low interest groupings.

COMPARATIVE INTERESTS

There were some significant differences in the leading items of interest of these two college groups.

First, the senior college students demonstrated a considerably greater interest in the item Parent Child Relationship than did the junior college students. Second, senior college students showed a lesser interest in the item Normal Sex Relations. Third, items such as Happiness with Home and Family and Mental Adjustments in Marriage showed increased interest with

---

[8]S. Laurence Bee, "Student Attitudes Toward A Course in Courtship and Marriage," *Marriage and Family Living*, **12**: 4, Nov. 1951, pp. 157-160.

[9]Joseph E. Lantagne, "Health Interests of 10,000 Secondary School Students," *Research Quarterly*, **23**: 3, Oct. 1952, pp. 330-346.

TABLE 1

Interest of 4,000 College Students in Preparation for Marriage and Parenthood

No.	Item	Junior College (%)	Senior College (%)	Total (%)
1	Parent-Child Relationships	65	69	67
2	Normal Sex Relations	66	63	64.5
3	Happiness with Home and Family	62	66	64
4	Mental Adjustments in Marriage	58	64	61
5	Religion and Marriage	60	57	58.5
6	Pregnancy—Problems	58	58	58
7	Living with the Opposite Sex	58	56	57
8	Responsibilities of Parents	57	58	57.5
9	Juvenile Delinquency—Prevention	59	55	57
10	Demands of the Opposite Sex	59	55	57
11	Wholesome Attitude toward Marriage	55	59	57
12	A College Education	58	52	55
13	The Family as a Unit	50	58	54
14	Birth Control—Problems	54	53	53.5
15	Marriage While in College	50	55	52.5
16	Causes of Divorce	55	49	52
17	Significance of Family Backgrounds	45	56	50.5
18	Desirable Age for Marriage	53	44	48.5
19	Planning and Budgeting	51	46	48.5
20	Problems of Mixed Marriages	48	46	47
21	Childbirth	48	46	47
22	Infant Care	48	46	47
23	Social Life for Parents	47	47	47
24	Dating	51	39	45
25	Engagement Period	48	42	45
26	Adjusting Marital Discord	41	49	45
27	Parents and the School	40	50	45
28	Physical Adjustments in Marriage	43	44	43.5
29	Social Adjustments	42	45	43.5
30	Premarital Counseling	40	47	43.5
31	Advantages of Early Marriage	43	43	43
32	Job or Probable Career	45	40	42.5
33	In-laws and Relatives	43	42	42.5
34	Health Considerations Before Marriage	44	40	42
35	Protocol, Reception, Honeymoon	44	38	41
36	Prenatal Care	39	43	41
37	How and Where to Live	44	35	39.5
38	The Prospective Family	39	38	38.5
39	Personality Appraisal	36	41	38.5
40	Controlling Extent of Necking	40	35	37.5
41	Premarital Examination	38	36	37
42	Planning the Wedding	38	33	35.5
43	Why We All Need Affection	36	35	35.5
44	Hereditary Characteristics	36	35	35.5
45	Why People Do Not Marry	35	36	35.5
46	Life, Auto, Health Insurance	35	35	35
47	Co-Recreational Activities	32	37	34.5
48	Immediate Care of the Mother	33	32	32.5
49	Health Disqualifications for Marriage	30	31	30.5

TABLE 1 (*Continued*)

No.	Item	Junior College (%)	Senior College (%)	Total (%)
50	Doctors and Health	31	29	30
51	Anatomical and Physiological Differences	27	32	29.5
52	Fertility	30	29	29.5
53	Employment Problems	32	26	29
54	Parents, Children, and Community	25	31	28
55	Venereal Diseases	35	21	28
56	Basic Dating Rules	32	22	27
57	Opportunities for Dating	30	24	27
58	Infant Mortality, Morbidity	21	18	19.5
59	Maternal Mortality, Morbidity	21	18	19.5
60	Chronic and Degenerative Diseases	21	15	18

TABLE 2

The 25 Items of Greatest Interest of 2,000 College Women in Preparation for Marriage and Parenthood

No.	Item	% Interested		% Vitally Interested		% Total Interest		Total
		Jr. Col.	Sr. Col.	Jr. Col.	Sr. Col.	Jr. Col.	Sr. Col.	
1	Parent-Child Relationships	39	44	29	25	68	69	68.5
2	Happiness with Home and Family	38	45	29	24	67	69	68
3	Mental Adjustments in Marriage	39	44	20	22	59	66	62.5
4	Pregnancy—Problems	40	45	23	15	63	60	61.5
5	Religion and Marriage	38	39	25	19	63	58	60.5
6	Wholesome Attitude Toward Marriage	40	45	18	18	58	63	60.5
7	Normal Sex Relations	39	41	21	19	60	60	60
8	The Family as a Unit	34	43	20	20	54	63	58.5
9	Responsibilities of Parents	38	39	20	18	58	57	57.5
10	Significance of Family Background	31	42	18	19	49	61	55
11	Living with the Opposite Sex	38	41	16	15	54	56	55
12	Marriage While in College	31	35	22	20	53	55	54
13	Demands of the Opposite Sex	33	38	20	16	53	54	53.5
14	Birth Control—Problems	30	37	24	15	54	52	53
15	A College Education	38	38	18	12	56	50	53
16	Causes of Divorce	35	36	21	13	56	49	52.5
17	Juvenile Delinquency—Prevention	31	36	22	15	53	51	52
18	Childbirth	33	39	20	11	53	51	52
19	Premarital Counseling	35	35	13	16	48	51	49.5
20	Social Life for Parents	36	37	12	11	48	48	48
21	Adjusting Marital Discord	30	37	13	14	43	51	47
22	Planning and Budgeting	34	37	18	5	52	42	47
23	Parents and the School	33	40	9	10	42	50	46
24	Infant Care	32	37	12	11	44	48	46
25	Problems of Mixed Marriages	30	31	14	14	44	45	44.5

senior college students. Fourth, both college groups demonstrated nearly the same interest in some items such as Pregnancy Problems, Responsibility of Parents, Birth Control Problems, Social Life of Parents, and Physical Adjustments in Marriage. Fifth, the variance in interest in the item of Dating was great; the senior college group indicated much less interest than the junior college group.

From a brief review of the facts, a few trends might be considered. The junior college students had a greater interest in such items as Dating, Engagement, and Age of Marriage. The senior college students indicated greater maturity by their increased response to such items as Parent-Child Relationships, Happiness with Home and Family, and Mental Adjustments in Marriage.

Then senior college students indicated a greater number of responses to each item and also more intensity of interest in certain specific items. This indicates that maturity brings a greater awareness of the need for understanding in this area of study.

TABLE 3

The 25 Items of Greatest Interest of 2,000 College Men in Preparation for Marriage and Parenthood

No.	Item	% Interested		% Vitally Interested		% Total Interest		Total
		Jr. Col.	Sr. Col.	Jr. Col.	Sr. Col.	Jr. Col.	Sr. Col.	
1	Normal Sex Relations	46	43	25	22	71	65	66
2	Parent-Child Relationships	38	42	24	28	62	70	66
3	Mental Adjustments in Marriage	40	44	18	19	58	63	60.5
4	Demands of the Opposite Sex	45	40	20	16	65	56	60.5
5	Happiness with Home and Family	35	40	21	24	56	64	60
6	Living with the Opposite Sex	43	39	18	16	61	55	58
7	A College Education	42	39	19	16	61	55	58
8	Responsibilities of Parents	38	40	17	20	55	60	57.5
9	Juvenile Delinquency—Prevention	38	39	20	12	58	57	57.5
10	Religion and Marriage	38	37	19	18	57	55	56
11	Pregnancy—Problems	39	42	16	14	55	56	55.5
12	Birth Control—Problems	32	35	21	19	53	54	53.5
13	Wholesome Attitude Toward Marriage	36	40	15	15	51	55	53
14	Causes of Divorce	34	37	20	13	54	50	52
15	Marriage While in College	31	33	17	21	48	54	51
16	The Family as a Unit	33	39	13	16	46	55	50.5
17	Planning and Budgeting	34	34	15	16	49	50	49.5
18	Social Life For Parents	34	36	11	10	45	46	45.5
19	Probelms of Mixed Marriages	32	34	13	12	45	46	45.5
20	Significance of Family Background	30	38	11	12	41	50	45.5
21	Parents and the School	27	38	12	13	39	51	45
22	Infant Care	32	33	12	12	44	45	44.5
23	Social Adjustments	31	35	10	12	41	47	44
24	Engagement Period	35	31	11	11	46	42	44
25	Adjusting Marital Discord	26	32	13	14	39	46	42.5

INTERESTS AS DETERMINED BY SEX

The 25 items of greatest interest to men will be found in Table 2, while the 25 items of greatest interest to women will be found in Table 3. Ninety per cent of these items were identical with both sexes. Items of greatest interest to women, that were not checked as readily by the men, were of a more typically feminine nature and included Childbirth, Infant Care, and Significance of the Family Background. Accordingly, women were not as concerned with problems such as A College Education, and Planning and Budgeting. These differences follow along the more typical female and male roles as they are commonly accepted by our society.

The males' primary interests include such items as Normal Sex Relations, and Parent-Child Relationships. As a secondary grouping of interests, the college male was concerned with Demands of the Opposite Sex, Living with the Opposite Sex, Mental Adjustments in Marriage, and A College Education. The third basic area of interest was Responsibilities of Parents, Juvenile Delinquency Prevention, and Religion and Marriage. As a fourth general problem area for men, such items as Pregnancy Problems, Birth Control

TABLE 4

The 20 Items of Greatest Interest of 2,000 Senior College Students According to Religion in Preparation for Marriage and Parenthood

No.	Item	Prot.		Cath.		Jew		Other		Total
		F	M	F	M	F	M	F	M	2,000
		(Percentage Interested)								
1	Parent-Child Relationships	70	71	70	67	88	64	65	65	69
2	Happiness with Home and Family	70	65	67	64	69	59	58	62	66
3	Mental Adjustments in Marriage	66	62	65	61	88	65	56	65	64
4	Normal Sex Relations	60	64	59	68	75	79	62	64	63
5	Wholesome Attitude Toward Marriage	63	53	61	54	69	64	64	57	59
6	Pregnancy—Problems	61	56	60	54	63	57	58	54	58
7	The Family as a Unit	63	57	61	52	69	51	57	48	58
8	Responsibilities of Parents	56	61	57	56	63	64	52	54	58
9	Religion and Marriage	56	54	69	59	52	56	42	45	57
10	Living with the Opposite Sex	56	54	55	53	63	67	57	53	56
11	Significance of Family Background	60	51	66	50	82	46	50	46	56
12	Juvenile Delinquency—Prevention	51	58	51	55	69	63	52	54	55
13	Demands of the Opposite Sex	55	54	53	57	69	64	50	56	55
14	Marriage While in College	56	58	50	48	75	52	50	54	55
15	Birth Control—Problems	54	54	45	52	69	56	41	55	53
16	A College Education	49	54	54	56	63	56	45	53	52
17	Parents and the School	50	54	46	48	76	42	48	39	50
18	Causes of Divorce	49	50	51	55	63	51	42	39	49
19	Adjusting Marital Discord	51	49	51	44	81	35	39	39	49
20	Social Life for Parents	48	46	50	40	75	60	33	44	47

Problems. Wholesome Attitudes Toward Marriage, and Causes of Divorce seemed to have priority.

Women were primarily concerned with the problems of the home which should normally tend to strengthen marital happiness. These items include Parent-Child Relations, Happiness in the Home, Mental Adjustments in Marriage, Pregnancy Problems, Wholesome Attitudes Toward Marriage, and Religion and Marriage. The second cluster of interests with the women included The Family as a Unit, Normal Sex Relations, and Responsibilities of Parents. A College Education and Marriage While in College likewise were considered very important, and this was consistent with the male thinking. The problems dealing with Demands of the Opposite Sex, Birth Control, Causes of Divorce, and Childbirth ranked in that order.

TABLE 5

The 20 Items of Greatest Interest of 4,000 College Students in Preparation for Marriage and Parenthood According to Religious Grouping

No.	Item	Prot.		Cath.		Jew		Other		Total
		F	M	F	M	F	M	F	M	4,000
		(Percentage Interested)								
1	Parent-Child Relationships	69	70	71	66	78	67	63	62	67
2	Normal Sex Relations	61	67	60	70	68	78	61	64	64.5
3	Happiness with Home and Family	69	60	70	62	67	61	58	56	64
4	Mental Adjustments in Marriage	64	61	62	57	69	65	53	62	61
5	Religion and Marriage	60	56	68	62	55	56	48	48	58.5
6	Pregnancy—Problems	62	55	62	57	62	58	61	51	58
7	Living with the Opposite Sex	55	56	57	57	60	69	55	56	
8	Responsibilities of Parents	57	58	60	57	57	63	52	52	57
9	Juvenile Delinquency—Prevention	54	57	56	59	57	63	49	53	57.5 57
10	Demands of the Opposite Sex	54	60	54	61	66	66	48	57	57
11	Wholesome Attitude Toward Marriage	62	51	63	53	52	61	55	50	57
12	A College Education	53	58	58	60	54	57	49	56	55
13	The Family as a Unit	59	50	59	49	53	54	52	46	54
14	Birth Control—Problems	55	55	47	54	62	55	49	52	53.5
15	Marriage While in College	56	56	51	46	59	49	41	48	52.5
16	Causes of Divorce	54	52	53	57	61	56	47	47	52
17	Significance of Family Backgrounds	58	49	62	51	62	46	40	42	50.5
18	Desirable Age for Marriage	44	52	46	52	55	57	44	49	48.5
19	Planning and Budgeting	53	47	51	50	54	48	54	45	48.5
20	Problems of Mixed Marriages	51	46	52	49	47	48	52	41	47

Of the ten items of least interest, the four to which there was least response were practically identical for both college women and men. Included were items such as Chronic and Degenerative Diseases and Opportunities for

Dating (See Table 6). Those problems pertaining to health and welfare seemed of little concern to the college student.

COMPARATIVE INTERESTS OF MEN

The 25 items of greatest interest to men of each groups were not identical, but had a correlation of .804. The item Normal Sex Relations of junior college men had the highest individual response (71%), while the item

TABLE 6

The Ten Items of Least Interest of 2,000 College Women in Preparation for Marriage and Parenthood

No.	Item	% Interested		% Vitally Interested		% Total Interest		Total
		Jr. Col.	Sr. Col.	Jr. Col.	Sr. Col.	Jr. Col.	Sr. Col.	
1	Chronic and Degenerative Diseases	14	10	5	2	19	12	15.5
2	Maternal Mortality, Morbidity	14	12	4	2	18	14	16
3	Infant Mortality, Morbidity	16	13	4	2	20	15	17.5
4	Venereal Diseases	19	13	7	3	26	16	21
5	Employment Problems	19	16	7	4	26	20	23
6	Opportunities for Dating	21	16	8	4	29	20	24.5
7	Anatomical and Physiological Differences	19	21	7	5	26	26	26
8	Health Disqualifications for Marriage	23	21	7	3	30	24	27
9	Doctors and Health	22	21	9	4	31	25	28
10	Basic Dating Rules	24	21	8	4	32	25	28.5

TABLE 7

The Ten Items of Least Interest of 2,000 College Men in Preparation for Marriage and Parenthood

No.	Item	% Interested		% Vitally Interested		% Total Interest		Total
		Jr. Col.	Sr. Col.	Jr. Col.	Sr. Col.	Jr. Col.	Sr. Col.	
1	Chronic and Degenerative Diseases	18	16	5	3	23	19	21
2	Infant Mortality, Morbidity	18	19	4	3	22	22	22
3	Maternal Mortality, Morbidity	18	19	5	3	23	22	22.5
4	Parents, Children, and Community	18	22	6	7	24	29	26.5
5	Planning the Wedding	23	21	7	5	30	26	28
6	Opportunities for Dating	25	23	7	4	32	27	29.5
7	Venereal Diseases	25	20	10	5	35	25	30
8	Basic Dating Rules	24	24	7	5	31	29	30
9	Fertility	21	26	9	6	30	32	31
10	The Prospective Family	23	20	16	11	39	31	35

Parent-Child Relationships had a 70 per cent response by senior college men. The next ten items of greatest interest were nearly identical for junior college and senior college men except that they were not in the same relative positions. The items of least interest were likewise identical except for the difference in relative positions.

COMPARATIVE INTERESTS OF WOMEN

The 25 items of greatest interest of junior and senior college women had a correlation of .748. The two items of greatest interest—Parent-Child Relationships and Happiness with Home and Family—had interest responses of approximately 68 per cent. Mental Adjustments in Marriage and Pregnancy Problems had approximately 62 per cent responses. These items were definitely clustered and seemed to indicate that women were interested and anxious to contribute to their feminine roles.

RELIGION

Although there were varying degrees of response by the different religious denominations represented, there were no significant trends. Of the 20 items of greatest interest that were analyzed (see Table 5), it was found that the interests of men and women of different religious belief were about equal in intensity.

College students of religious beliefs other than the Catholic, Protestant, and Jew, had the least intensity of interest. The range of response by men and women students to the various items of greatest interest was Protestants, 0-11 per cent; Catholic, 0-11 per cent; Jews, 0-16 per cent; and others, 1-17 per cent. The item Religion and Marriage had one of the most consistent responses by all religious groupings.

Conclusions

1. There is a high level of student interest in marriage and parenthood problems. The 2,000 senior college students participating indicated an average interest of 42.9 problems per student as compared to 26 items per student in the junior college group.

2. Marriage problems can be measured with a reasonably high degree of reliability.

3. There were varying degrees of intensity of these interests; however, these differences primarily reflected an appropriateness of the problem to the related sex.

4. The range of interests in response to this inventory was from 16 to 69 per cent for college women and was from 21 to 71 per cent for college men. There was a high relationship of interests between men and women throughout the study.

5. Problems that might normally seem of little concern to college students, such as Parent-Child Relationship and Happiness with Home and Family, have demonstrated a very high interest rating.

6. Differences of religious beliefs of college students were inconsequential and did not materially affect the responses to items.

Recommendations

1. In order to make instruction in the area of marriage and parenthood more meaningful, instructors should find it desirable to survey the interests of their students as a guide for instruction.

2. The similarity and intensity of interests of men and women should encourage coeducational classes in the area of marriage and parenthood.

3. Religious differences provide little evidence as a basis for segregation of students.

4. Curricular deans and administrators should recognize that marriage education is important and should be an integral part of the general education of all college students.

5. The availability of college courses in preparation for marriage and parenthood should be encouraged by administrators and counselors.

6. Courses in marriage and parenthood should be broadened in scope to incorporate the interests and needs of college students.

7. Findings of this study indicated that junior and senior college courses should be geared to their maturity levels.

(Submitted 11/18/55)

Cross Transfer Effects of Training on Strength and Endurance

DONALD K. MATHEWS
Washington State College
Pullman, Washington
CLAYTON T. SHAY, FRANK GODIN and ROBERT HOGDON
Springfield College
Springfield, Massachusetts

Abstract

Twenty-eight Springfield College students were exercised, using the elbow flexor muscle group, three times a week for a period of four weeks on the Kelso-Hellebrandt ergometer. There was a significant gain in strength in both the exercised and unexercised muscle groups. Significant increases in muscular endurance were found only in the exercised muscle group.

THE PHENOMENON OF cross transfer of strength from one muscle group to the opposite has received considerable attention in recent literature.

However, as early as 1894, Scripture *et al* (6) demonstrated that by exercising the right hand the left hand also increased in strength. The authors used a mercury dynamometer which consisted of a rubber bulb attached to a glass tube containing mercury. The effects of training were recorded in inches the mercury could be raised by squeezing the bulb. After nine exercise bouts, the bulb pressure for the right hand increased from 28.8 to 48.6 inches of mercury. The left hand (unexercised) also increased from 29.6 to 42.3 inches, indicating a cross transfer of strength.

More recently, Hellebrandt (5) and associates by using resistive exercises demonstrated similar findings.

The actual cause for this cross transfer of strength is not completely understood. Among a few of the theories governing cross transfer, Wissler and Richardson (7) suggest that there is a diffusion of motor impulses to the contralateral arm.

Hellebrandt and associates make reference to another theory (3) which suggests that cross transfer results from the widespread synergistic fixations of the contralateral musculature. The tensing or fixation of the opposite muscles caused by exertion of the exercised muscle group results in increased strength of the "unexercised" muscles. The answer to this problem remains in the hypothetical stage.

Purpose of the Study

The purpose of this study was to determine the training effects of exercising the elbow flexor muscles of one arm upon strength and endurance of similar muscles of the other arm.

Research Procedures

ORIENTATION OF SUBJECTS AND TESTERS

Before experimental data were collected, the examiners demonstrated their competence in obtaining consistent results in the use of the elbow-flexion cable-tension strength tests and the Kelso-Hellebrandt ergometer.

Strength Testing. The instrument used to determine the strength of the elbow flexor muscles was a specially adapted aircraft tensionmeter. The testing method was patterned after that described by Clarke (2).

Ergometric Testing. The instrument used to exercise and record the endurance of the elbow flexor muscles was the Kelso-Hellebrandt ergometer which represents a modification of one first used by Treves. The lever arm is attached to a wheel and axle which permits the angle of application of the load to remain constant throughout the motion of the arm.

Endurance was measured in terms of distance the load was raised during a prescribed test bout and was recorded in centimeters from a counter attached to the ergometer.

The load placed on the ergometric carriage was three-eighths of maximum strength of the flexors obtained in the first strength test. In a previous study it was found that this strength proportion resulted in objectivity coefficients of *.90* (1).

Owing to the mechanical advantage of the ergometer, the actual load carried, if computing work done, would be approximately one-half of the weights placed on the ergometer or three-sixteenths of the elbow flexor's strength.[1]

The cadence was 30 per minute given by an electric timer. The complete cycle of flexion and extension was completed in two seconds, one second for raising the load and one second for lowering the load. Stress was placed on accomplishing a smooth constant movement with no rest pauses in between.

SUBJECTS

The subjects were 28 Springfield College male students. The median age was 21.6 years; the middle 50 per cent ranged from 19.8 to 22.6 years. The heights ranged from 65.0 to 80 inches. The median height was 71.1 inches. The weights to the nearest half pound ranged from 135 to 220 pounds. The median weight was 163.5 pounds.

EXPERIMENTAL PROCEDURES

Strength and endurance for the left elbow flexor muscles was measured three times a week for four weeks. The right elbow flexor muscles were tested only at the beginning and the end of the experiment.

The subjects exercised until exhaustion. As a consequence, the duration of exercise was from one and one-half to two minutes each time. The weights were raised between 45 and 60 repetitions. The total length of time each subject actually exercised during the four weeks was estimated at 25 minutes.

---

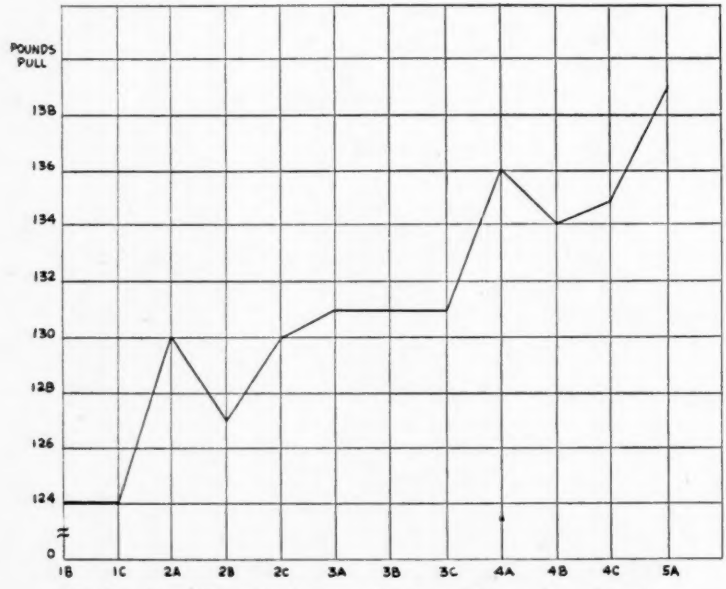
[1]The theoretical mechanical advantage of this instrument is computed by comparing the pitch ratios of the wheel to the length of the lever arm. In this case, it was 1:2.

Statistical Treatment

The analysis of data was based upon the comparison of means of the strength and endurance measurements. The standard error formula for the difference between means of correlated groups was used, inasmuch as the study was in the nature of a single group experiment. Significance at the .05 and .01 levels of confidence, respectively, is denoted by t-ratios of 1.70 and 2.47.

Results

Table 1 contains the data for the strength gains to the left or exercised arm. The strength increased from 125 to 140 pounds, a gain of 12 per cent. This increase was statistically significant beyond the .01 level of confidence. These data are graphically portrayed in Figure I.



Testing days: Numerals denote weeks; letters denote days of week.

FIGURE I. Mean Strength in Pounds Pull of Elbow Flexion Muscles Due to Exhaustion Bouts with These Muscles. Data: 1954; 28 subjects.

Table 2 shows the results of strength gains to the right or unexercised arm. The strength of this muscle group increased from 127 to 135 pounds—an increase of 6.30 per cent. This difference was statistically significant beyond the .01 level of confidence.

Table 3 shows the results of the endurance scores for the exercised arm. There was an increase from 745 cm to 818 cm, a 9.80-per-cent gain for this

TABLE 1

Mean Strength in Pounds Pull Prior to Elbow Flexion Exhaustion Bouts of the Exercised Arm

Bouts	Means (pounds)	Difference Between Means		
		Diff.	S. E. Diff.	t-ratios
1B	125			
1C	124	----		
2A	130	6.12	2.14	2.86*
2B	128	—2.32	2.03	1.14
2C	131	3.58	1.76	2.03
3A	131	----	----	----
3B	131	----	----	----
3C	132	----	----	----
4A	137	5.27	2.06	2.56*
4B	135	—2.17	2.01	1.08
4C	137	----	----	----
5A	140	3.16	2.68	1.18

*Significant beyond the .01 level of confidence.
NOTE: Letters indicate testing bouts, numerals indicate weeks. Hence 2A is second week, first testing bout.

TABLE 2

Mean Strength in Pounds Pull Before and After Elbow Flexion Exhaustion Bouts of the Unexercised Arm

Bouts	Means (pounds)	Difference Between Means		
		Diff.	S. E. Diff.	t-ratios
First	127			
Second	135	8.02	1.99	4.03

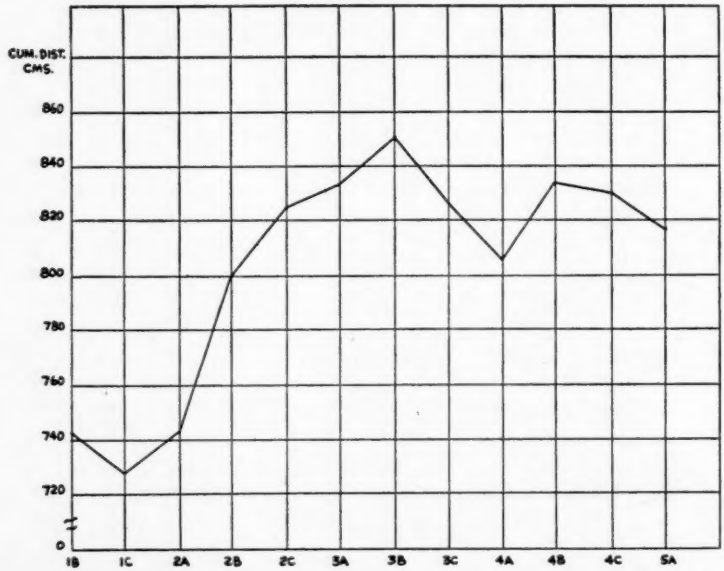
TABLE 3

Mean Distances in Centimeters Ergometric Weights Were Moved During Elbow Flexion Exhaustion Bouts of the Exercised Arm

Bouts	Means (cm.)	Difference Between Means		
		Diff.	S. E. Diff.	t-ratios
1B	745			
1C	733	—11.73	15.84	.74
2A	740	7.48	19.60	----
2B	802	61.93	23.22	2.67*
2C	823	20.63	17.92	1.15
3A	836	13.28	5.57	2.38
3B	852	16.20	15.40	1.05
3C	833	—19.74	26.57	----
4A	808	—23.47	19.60	1.20
4B	835	27.64	9.90	2.79*
4C	830	— 5.28	16.16	----
5A	818	—12.00	16.73	----

*Significant beyond the .01 level of confidence.
NOTE: Letters indicate testing bouts, numerals indicate weeks. Hence 2A is second week, first testing bout.

muscle group. The difference was significant beyond the .01 level of confidence. These data are graphically portrayed in Figure II.



Testing days: Numerals denote weeks; letters denote days of week.

FIGURE II. Mean Distance in Centimeters Ergographic Loads Were Moved During Elbow Flexion Exhaustion Bouts. Data: 1954; 28 subjects.

Table 4 denotes the endurance scores for the unexercised elbow flexor muscle group. The increase in endurance was from 710 cm to 725 cm, or a 2.11 per cent gain, which was not statistically significant.

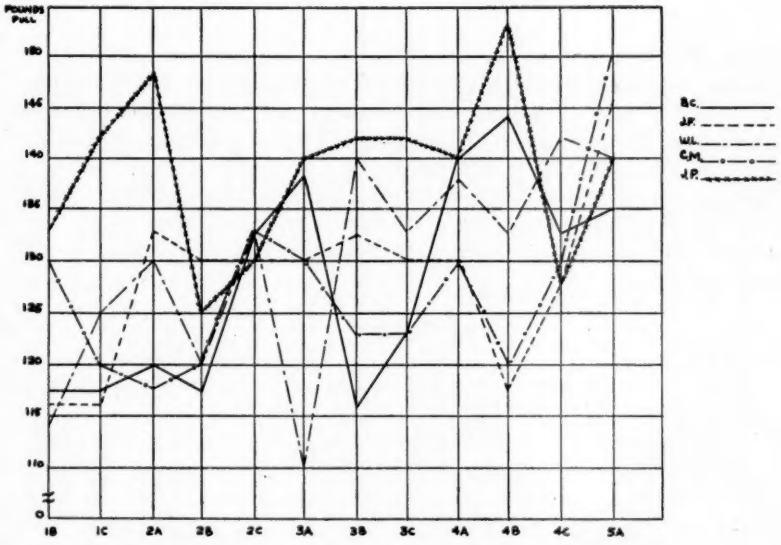
TABLE 4

Mean Distances in Centimeters Ergometric Weights Were Moved During Elbow Flexion Exhaustion Bouts of the Unexercised Arm

Bouts	Means (cm.)	Difference Between Means		
		Diff.	S. E. Diff.	t-ratios
First	710			
Last	725	14.85	19.37	.77

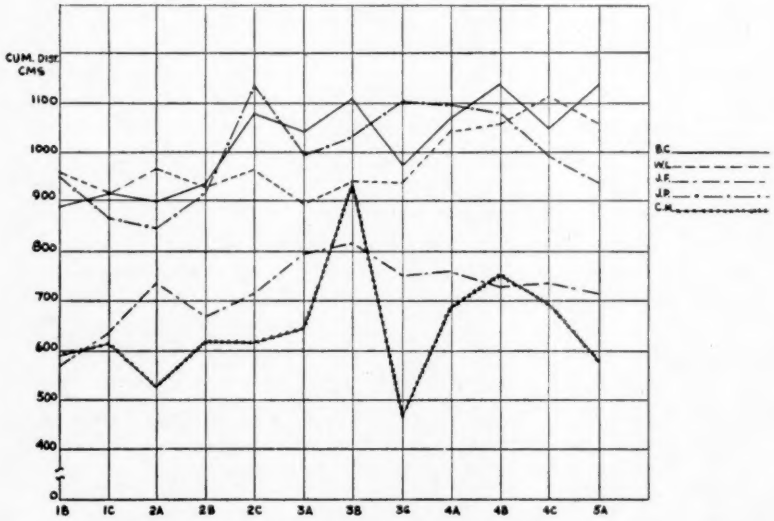
INDIVIDUAL SCORES

Individual scores of strength and endurance for five subjects selected at random were graphed to show the relative increase in strength and endurance as the exercise progressed from week to week. (See Figures III and IV.) The variations of the individual performances indicate that the conditioning effect is highly individualized.



Testing days: Numerals denote weeks; letters denote days of week.

FIGURE III. Pounds Pull of Elbow Flexion Muscles by Five Subjects Prior to Exhaustion Bouts with These Muscles. Data: 1954.



Testing days: Numerals denote weeks; letters denote days of week.

FIGURE IV. Distance in Centimeters Ergograph Loads Were Moved by Five Subjects During Elbow Flexion Exhaustion Bouts. Data: 1954.

Conclusions

The major types of muscular contractions in this study were both isotonic and isometric. During the ergometric exercise, the muscular contractions were isotonic. Strength tests were administered prior to each exercise bout; the contraction was static or isometric.

The increases in strength for both the exercised and non-exercised arm were statistically significant. The endurance gains for the exercised arm were also statistically significant. No significant increase in endurance resulted to the unexercised arm.

REFERENCES

1. Bridgman, Arthur C., Robert W. Lynch, and Arthur E. Williams, *Precision of Elbow Flexion Ergography Under Varying Degrees of Muscular Fatigue,* Unpublished Master's thesis, Springfield College, Springfield, Mass.
2. Clarke, H. H., *A Manual: Cable-Tension Strength Tests,* Chicopee, Mass.: Brown-Murphy, 1953. 32 pp.
3. Davis, W. W., Researches in cross education, *Studies Yale Psychological Laboratory,* **6**: 6-50, 1898.
4. Garrett, H. E., *Statistics in Education and Psychology,* New York: Longmans, Green and Co., 1953. p. 427.
5. Hellebrandt, F. A., S. J. Hantz and A. M. Parrish, The Influence of unilateral exercise on the centrilateral limb, *Archives of Physical Medicine,* **27**: 76-85, 1947.
6. Scripture, E. W., T. L. Smith, and E. M. Brown, On the education of muscular control and power, *Studies Yale Psychological Laboratory,* **2**: 118, 1894.
7. Wissler, C. E., and W. R. Richardson, Diffusion of the motor impulse, *Psychological Review,* **7**: 38, 1900.

(Submitted 6/15/55)

A Factor Analysis of Tests of Endurance[1]

C. H. McCLOY
State University of Iowa
Iowa City, Iowa

Abstract

A factor analysis was computed on 12 athletic events, administered to 400 well-conditioned soldiers. Of these events, four could be considered to be tests of circulo-respiratory endurance, four were tests of muscular endurance, and the others were tests of speed. In addition four combinations of tests were included.

Four factors were found, one of circulo-respiratory endurance, one of velocity, one of muscular endurance, and one tentatively identified as mesomorphic body build. One important finding was the high factor weighting of the endurance index (300 yards run + 6 seconds run) with circulo-respiratory endurance (.8835).

THE STATISTICAL-RESEARCH method termed "factorial analysis" is being increasingly used to determine the basic factors or components making up different tests of physical or mental or emotional abilities. The purpose of the factorial analysis is to analyze the *pure* factors or components of which a given test is composed. For example, in the running high jump there are always at least three factors, one being the amount of *force* which the individual can exert in the jump, one being the *potential contraction speed* of his muscles, and the other being what the writer has termed "*dead weight*" or that part of his weight not contributing to the athletic effort. For example, this would be composed of fat of skin, viscera, and other things like that. This third factor will usually be loaded negatively, that is, it detracts from the performance.

In factorial analysis for physical education and athletics events, the method commonly called that of "orthogonal" factors is usually used. That is, the effort is made to determine those "pure" factors which are unrelated each to the other. When any two of these factors are plotted, their basic axes are at right angles to each other.

This is not the place to go into methods of doing a factorial analysis and two references will be given from which details may be secured.[2]

Incidentally, it has been the experience of the author in doing factor analyses of motor activities that unless some tests of strength, uncomplicated by

---

[1]For a discussion of the different types of endurance, see C. H. McCloy, "Endurance," *The Physical Educator*, March 1948.

[2]L. L .Thurstone, *Multiple-Factor Analysis.* Chicago: The University of Chicago Press, 1947. *Research Methods Applied to Health, Physical Education, and Recreation.* Washington, D. C.: American Association for Health, Physical Education, and Recreation, 1949.

other elements, are included in the test battery, it is extremely difficult to rotate the so-called centroid factorial matrix intelligently. Hence individuals gathering data to be used for a factorial analysis should, in the opinion of the author, include at least three or four tests of pure strength, such as leg strength, back strength, strength of chest muscles, and strength of grip of right and left hands.

Procedure

In the present study, 12 athletic events were chosen for a factorial analysis, and then four composite events, made up by combining a number of tests, were added. The subjects were 400 well-conditioned soldiers who had been in rather strenuous training for about six months. As will be seen from the accompanying table, the 12 events were: (1) the 12-pound shot put, put from a stand; (2) three standing broad jumps, done in succession; (3) a 20-yard shuttle run in which the man ran back and forth for 20 seconds; (4) a 6-second run; (5) the 300-yard run; (6) an endurance index, or endurance score, computed from the 300-yard run and the 6-second run which was converted into units of time;[3] (7) a 75-yard run in which the runner carried a man within five pounds of his own weight astride his back ("pick-a-back run"); (8) an endurance index in which the time for this man-on-the-back run was equated against the time for the 6-second sprint as was the case with the 300-yard run; (9) a 20-second squat thrust (the individual, upon the command "Go," quickly places his hands on the ground in front of his feet, thrusts the legs backward to full length, and returns in reverse order, the whole being a four-count movement); (10) chinning the bar or pulling up until the chin is above the bar; (11) push-ups on the ground; and (12) sit-ups, done with the hands behind the head, doing as many sit-ups as possible in two minutes.

The four composite events were as follows: (a) a muscular endurance combination of chinning or pull-ups, push-ups, sit-ups, and squat jumps; (b) a circulorespiratory endurance combination of the 300-yard run, a 440-yard run, a mile run, a 60-second squat thrust, and the run with the man astride the back; (c) a speed event combination which was made up of points for the 6-second run, a softball throw for distance, standing broad jump, three standing broad jumps, and the shot put; (d) total points for all events tested—a total of 20 different events.

Results

When factored, the factorial analysis table shows the results. In this table the "factor loadings" correspond to coefficients of correlation with the factor indicated. The last column, *h*, the *Communality*, represents the coefficient of multiple correlation of the variable with the four factors.

---

[3]Charles Harold McCloy and Norma Dorothy Young, *Tests and Measurements in Health and Physical Education*, 3rd ed. New York: Appleton-Century-Crofts, Inc., 1954, pp. 183-89.

TABLE 1
Rotated Factor Loadings

Event	Circulorespiratory endurance	Velocity, or muscular contraction speed	Muscular endurance	(Mesomorphic build)	Communality
	I	II	III	IV	h
1. Shot put	.3085	.4414	.2501	.1351	.6089
2. Three broad jumps	.2765	.5993	.3526	.0789	.7525
3. Shuttle run	.2487	.6720	.0423	−.1475	.7327
4. Six-second sprint	.0941	.6363	.5045	−.0933	.8226
5. 300-yard run	.7948	.4417	.1243	−.1001	.9231
6. 300/6 sec. run	.8835	.0652	−.1953	−.1027	.9130
7. 75-yd. Pick-A-Back run (with man on back)	.6139	.3264	.3304	.5794	.9634
8. Pick/6 sec. (run with man on back, equated with 6 sec. run)	.6542	.1335	.1660	.6302	.9330
9. 20-second squat thrusts	.4893	.1318	.4531	.0327	.6807
10. Chinning or pull-ups	.3977	.0861	.4269	−.0349	.5908
11. Push-ups	.5525	−.0366	.5746	.0184	.7982
12. Sit-ups	.4674	−.0279	.5821	−.0442	.7484
A. Muscular endurance events composite	.5835	.1671	.7178	.0103	.9401
B. Circulorespiratory endurance events composite	.8964	.2695	.1152	.2790	.9835
C. Speed events composite	.2482	.8693	.3441	−.0894	.9956
D. Total points—all tests	.7221	.5119	.4427	−.0136	.9897

The first factor seems to be circulorespiratory endurance. Here it will be seen that variables 6 and 8 give a higher correlation with this factor than do variables 5 and 7, where speed has not been held constant.

The second factor seems to be speed, as this factor is heavily weighted in the first five events and not in the following ones. It is also heavily weighted in the speed events composite.

The third factor seems to be muscular endurance. The heavy weightings are in the 6-second sprint, the squat thrust, chinning or pull-ups, push-ups, and sit-ups.

The fourth factor is not identified. It is present only in the two runs in which a man is astride the back of the runner, and in view of the fact that the individuals who seemed to do best in this event were the stocky, mesomorphic type of individuals, we have tentatively thought of this as a possible indication of that type of build. Further studies will have to be done, however, before such an identification can be made with confidence.

The heavy loadings of the first three factors in the composite scores at the bottom of the page seem, in general, to confirm our identifications. It will be

noted that the weighting of variable 6 (.8835) is almost as high as that for the whole endurance combination—variable B (.8964).

Need for Research

The most significant finding of this study is the very high weighting that is given to this endurance score of the 300-yard run divided by the 6-second run. It is felt by the author that this type of measurement of circulorespiratory endurance has very high potentialities. The author feels that a considerable amount of research along these lines should be conducted in order to provide tests of pure circulorespiratory and pure muscular endurance as distinguished from mixtures of these various types.

(Submitted 9/26/55)

Comparative Effects of Rest, Exercise, and Cold Spray Upon Performance in Spot-Running

FRANK D. SILLS AND VERNON E. O'RILEY
State University of Iowa
Iowa City

Abstract

The purpose of the study was to compare the effects of rest, exercise, and cold applications upon physical performance. Eighteen college men students served as subjects. They performed five bouts of spot-running, with ten-second intervals between the bouts. After they rested, exercised, or received cold applications for ten minutes, they performed another series of five bouts of spot-running. The best performance followed the application of the cold spray to the lower half of the abdomen.

STEINHAUS, KELSO, and Reinhardt (3) have reported that, for two and one-half to six hours, cold hip baths improve visual functions, tapping rate, and eye-to-leg muscle co-ordination. Happ, Tuttle, and Wilson (1) have reported that cold packs applied to the abdomen facilitate recovery from fatigue. Wallrich and Dawson (4) have reported that short rest periods in connection with heavy exercise increase physical efficiency and, in connection with light exerise, decrease physical efficiency.

The purpose of the present investigation was to compare the effects of a rest period, exercise, and a cold spray upon performance in spot-running.

Subjects and Data

Eighteen men, who were students at the State University of Iowa, and who ranged in age from 19 to 28 years, served as subjects.

After warming up by walking and jogging around an indoor track for five minutes, the subject performed five ten-second bouts of spot-running (hereafter referred to as initial bouts), with a ten-second interval between each bout. The number of steps taken by the right foot was registered by means of the Sills electric contactor (2). After the initial five bouts, the subject, on one day rested, on another day exercised, and on still another day had a cold spray applied to his abdomen. After each of these treatments the subject performed five more ten-second bouts of spot-running, with a ten-second interval between each bout.

During the rest period the subject lay in a supine position for eight minutes. For the exercise the subject walked and jogged for ten minutes. For the cold application the subject had his abdomen sprayed for eight minutes with water, the temperature of which ranged from 44° F to 48° F.

The 18 subjects were divided into three groups of six subjects each. On Monday, Wednesday, and Friday of two successive weeks, the members of the three groups performed according to the order that follows:

Day	*Group One*	*Group Two*	*Group Three*
M	Rest	Cold spray	Exercise
W	Exercise	Rest	Cold spray
F	Cold spray	Exercise	Rest
M	Exercise	Rest	Cold spray
W	Cold spray	Exercise	Rest
F	Rest	Cold spray	Exercise

Analysis of Data

The mean of the number of steps taken by the 18 subjects prior to each of the three treatments was recorded. The difference between each mean and the other two means, as shown in Table 1, was not significant.

TABLE 1

Analysis of Means for Initial Bouts of Spot-Running

Time	Steps (no.)	Difference	t	P
Before rest	471.944			
Before exercise	471.611	.333	.055	.90
Before cold applications	472.055	.444	.089	.90
Before rest	471.944	.111	.020	.90

In Table 2 appear the means of the number of steps taken by the 18 subjects before and after each of the three treatments, the difference between the means of the number of steps taken before and after each of the treatments, and the statistical significance of the difference between each difference and the other two differences.

TABLE 2

Analysis of Means for Initial and Final Bouts of Spot-Running as Related to Rest, Exercise, and Cold Applications

Time	Steps (no.)	Difference	Difference Between Differences	t	Level of Statistical Significance P
Before rest	471.944				
		13.000 (B)			
After rest	484.944		3.556	.646	.60
Before exercise	471.611				
		9.444 (C)			
After exercise	481.055		12.056	2.300	.05
Before cold applications	472.055				
		21.500 (A)			
After cold applications	493.555		8.500	1.895	.10
Before rest	471.944				
		13.000 (B)			
After rest	484.944				

The difference (A) between the means of the number of steps performed before and after cold applications was greater than the difference (B) between the means of the number of steps performed before and after rest, which difference, in turn, was greater than the difference (C) between the means of the number of steps performed before and after exercise. The difference ($P = .05$) between the first (A) and the third difference (C) was greater than the difference ($P = .10$) between the first (A) and the second difference (B), which difference in turn, was greater than the difference ($P = .60$), between the second (B) and the third difference (C).

Summary of Findings

In summary, on the basis of the findings in this study, physical performance as measured by spot-running is improved more by cold applications than by either rest or exercise, and more by rest than by exercise. If the difference between the number of steps performed in the initial and final bouts is considered to be a measure of the recovery from fatigue, then further, on the basis of the findings in this study, cold applications are more effective than either rest or exercise for the recovery from fatigue.

REFERENCES

1. Happ, William P., W. W. Tuttle, and M. Wilson, The Physiological Effects of Cold Abdominal Packs. *Research Quarterly*, **20**: 153-64, 1949.
2. McCloy, Charles H., and Norma D. Young, *Tests and Measurements in Health and Physical Education*. New York: Appleton-Century-Crofts, Inc., 3rd ed., 1954.
3. Steinhaus, Arthur H, Albert Kelso, and Victor Reinhardt, The Improvement of Visual and Other Functions by Cold Hip Baths. *Research Quarterly*, **14**: 610-17, 1943.
4. Wallrich, L. A., and P. M. Dawson, The Effect of Short Spells of Rest on Physical Efficiency as Measured by a Bicycle Ergometer. *Amer. Jour. of Physiology*, **55**: 478, 1921.

(Submitted 7/15/55)

Relation of Certain Physical Traits and Abilities to Motor Learning in Elementary School Children[1]

JEAN A. SMITH
Southwest Texas State Teachers College
San Marcos, Texas

Abstract

The investigator studied the physical traits and abilities of elementary school children in relation to their ability to learn a ball bounce and a ball toss motor skill. Statistical significances between the fast and slow learners were determined by computation of the *t* ratios. Regression equations were computed in score form. Many of the physical and motor ability measures differentiated significantly the fast and slow learners. Analysis of the multiple correlations indicate there are some physical traits and abilities which contribute toward motor learning but there are evidently more.

LEARNING MOTOR SKILLS and tuition in motor skills are primary concerns of physical educators. Maturation, individual ability, practice, and tuition (or instruction) affect the acquisition and learning of motor skills. Tests of physical traits, motor ability and motor educability have been developed in physical education, but a problem arose as to whether these tests differentiated fast motor learners from slow ones in the first three elementary grades.

The purpose of this study was to determine the relation between certain physical traits[2] and abilities[3] and the speed of learning certain motor skills. Essentially, the study attempts to answer the following questions: (a) Do any of the physical and motor traits and abilities differentiate between fast and slow learners? (b) Do the so-called tests of motor educability relate to the ease with which a new motor skill is learned? (c) Is there any combination of physical and motor traits and abilities which will predict ease of learning motor skills?

Major strides have been made concerning the conditions under which learning may take place, the inter-relationships among certain physical traits, motor ability, motor capacity, and the relation of physical traits and abilities to performance of motor skills. Considerable attention has been focused on problems of techniques, methods of teaching, the study of muscular move-

[1]This study was made under the direction of Dr. Marjorie Phillips, School of Health, Physical Education, and Recreation, Indiana University, Bloomington, Indiana.

[2]Physical traits are such individual characteristics as body build and sex. In the present study the primary "trait" difference was sex.

[3]Ability is the degree of strength, power, coordination, etc., as shown by motor skill tests.

ments; but little has been accomplished in studying the relation of physical traits and abilities to the rate of motor learning. Obviously, some individuals may be capable of learning certain motor skills more easily than others, some individuals may learn all sport activities with comparative ease, and variance in the speed of learning fine and gross motor skills exists. Most studies on motor learning have been confined to children under five years of age and to pre-adolescent, adolescent, and college age students. Studies have been made on children in the first three primary grades.

Procedure

The original group consisted of 156 boys and girls attending the elementary schools in Bloomington, Indiana, during the spring and fall school semesters of 1952. The criteria for selection of subjects were the teacher's estimate of co-operation and child's interest. Children who failed to meet the twice weekly practice sessions, or to co-operate, were dropped. The final experiment group used in this study numbered 100.

The subjects ranged in age from six to nine years. None of the subjects had apparent physical defects. All the subjects were (as it happened) right-handed. The final experimental population consisted of 35 children in the first grade, 31 children in the second grade, and 34 children in the third grade. There were 51 boys and 49 girls.

The study was conducted in an environment similar to a classroom, except that the number of students per "class" was six, three boys and three girls. Each motor skill was practiced for six weeks with two 20-minute periods weekly. No individual guidance was given; all clues, comments, and directions were given to the whole class before the practice session.

The first learning skill, a ball toss for accuracy, involved tossing balls at a metal basket ten feet away. Each child in the class had ten balls and a small pail to hold them. Target pails were four feet apart, 13 inches top diameter and 14½ inches high. Five trials of ten throws each were given in the practice periods. The test consisted of tossing 100 balls at the basket; the score was the number falling in.

The second learning skill, a ball bounce, involved giving impetus to the ball twice and swinging the preferred leg over, repeating as many times as possible without breaking the rhythm or stepping out of his circle. Each child in the class had one semi-solid rubber ball, nine and a half inches in circumference, and practiced in a circle, four feet in diameter, which was three feet from adjacent circles. The skill was performed for ten minutes each practice period. The test consisted of repeating the described skill as many times as possible without breaking the pattern of three trials (one point for each cycle) and the highest score of three trials was considered the test score.

During the first week of the experimental period, an effort was made to establish rapport with the children. The initial ball toss test was administered at the second meeting of the group. The learning period for the ball toss skill

began the third time the group met. The final ball toss test was administered during the period following the 12th practice session. The initial test was given the same period. Practice on the ball bounce skill commenced at the 16th meeting of the group; the final test was administerd on the 28th meeting. The other tests were administered during the 14-week experimental period.

Available tests for measuring physical traits and abilities of children in the primary grades were assembled and classified according to use and abilities measured. These tests were analyzed and evaluated subjectively in terms of validity, reliability, and administrative feasibility.

TEST	TRAIT MEASURED	REFERENCE
Brace Motor Ability (all items)	Motor Ability	3
Iowa-Brace (all items)	Motor Educability	9
Carpenter Motor Educability (all items)	Motor Educability	4
Springfield Balance Beam	Dynamic Balance	11
Balance Stick	Static Balance	10
Cureton Flexibility Test	Speed	
trunk flexion	Flexibility	1;5
trunk extension		
shoulder flexion		
ankle flexion		
Grip Strength	Strength	
Steven's Kinesthesis Tests[4]	Kinesthesis	13

Statistical Treatment

The analysis of learning data was based upon the raw scores made on the ball bounce and the ball toss tests, and a combined motor learning score averaging T-scores of the ball bounce and ball toss tests. The two learning-ability groups were divided at the mean on each test; those above were considered fast learners and those below slow. Groups were also compared according to sex.

Results

Limited space necessitates condensation of the discussion to significant findings. The reader is referred to the dissertation for a more complete interpretation (12).

Prior to analyzing the data according to the various groupings, Garret's formula (6, *p. 209*) for the single group method was used to verify that learning occurred during the experimental period. The correlation between the initial and final ball toss test was .61: the standard error of the difference of 9.13 is significant at better than the .01-per-cent level of confidence. The correlation between the initial and final ball bounce test was .57: the standard error of the difference of 8.91 is significant at better than the .01-per-cent level of confidence.

[4]The kinesthesis measures of arm and leg positions recorded in degrees of error.

Table 1 gives the means and standard deviations for the motor learning skills when the data were analyzed by the various groupings. It should be noted the distribution of the final ball bounce test is skewed.

TABLE 1
The Mean and Standard Deviation for the Motor Learning Skills

Group	Ball Bounce		Ball Toss		Combined Score	
	M	S.D.	M	S.D.	M	S.D.
Entire group						
Initial test	1.01	1.27	3.75	3.17		
Final test	11.43	12.39	20.91	9.92	49.92	8.87
Fast learners	26.63	13.24	29.17	7.00	57.71	7.89
Slow learners	5.81	2.73	13.29	4.78	44.04	3.30
Boys						
All boys	13.78	10.32	24.98	9.06	52.91	9.02
Fast learners	30.87	15.49	32.49	6.50	62.32	7.64
Slow learners	6.67	2.97	17.48	3.65	47.33	3.35
Girls						
All girls	8.98	9.76	16.67	8.94	46.81	7.55
Fast learners	18.25	12.52	24.00	6.61	53.05	6.91
Slow learners	4.48	1.86	9.64	3.71	41.72	2.64
Boys vs. Girls						
Boys	13.78	10.52	24.98	9.06	52.91	9.03
Girls	8.98	9.76	16.67	8.94	46.81	7.53

An analysis of the data when grouped according to each motor learning skill and the combined learning score (Table 2) indicate all the test batteries designed to measure motor ability and educability differentiate significantly between the fast and slow learners. Of the tests designed to measure physical skill, Grip Strength shows the highest t values between the two learning groups. In the measures of kinesthesis (not shown on the table) the Arm Forward 110° right was the only test which differentiated significantly the fast and slow learners in all three groupings. The Side Arm 90° right and Side Arm 110° left differentiated between the fast and slow learners on the ball toss but not the ball bounce skill. The measures of leg kinesthesis differentiated between the fast and slow learners on the ball bounce skill but not the ball toss.

Examination of Tables 3 and 4 indicates there are physical and motor measures that differentiate significantly between the fast and slow learners (as measured in this study) of both sexes. All the test batteries designed to measure motor ability and educability differentiate between fast and slow learners of both sexes; the Carpenter shows the greatest difference between learning groups in both boys and girls. The tests of physical skill indicate Grip Strength was the test which best differentiates the two learning groups in the girls: the Balance Beam was the best for the boys. The better test for balance in both sexes seems to be the Balance Beam.

TABLE 2

Mean Differences on Physical and Motor Skill Tests Between Fast and Slow Learning Groups (All Subjects)

Tests	Ball Bounce				Ball Toss				Combined Score			
	Group	Mean	S.D.	t	Group	Mean	S.D.	t	Group	Mean	S.D.	t
Motor Ability-Educability												
Brace	A[1]	13.22	2.45	3.81*	A[3]	12.44	2.84	3.36*	A[5]	12.88	2.56	4.54*
	B[2]	10.74	3.00		B[4]	10.46	2.97		B[6]	10.30	2.95	
Iowa-Brace	A	17.22	3.44	3.52*	A	16.27	3.64	3.36*	A	16.79	3.43	4.21*
	B	13.97	4.27		B	13.52	4.45		B	13.39	4.33	
Carpenter	A	20.37	6.71	5.13*	A	16.73	7.20	2.95*	A	17.35	7.34	3.41*
	B	12.16	7.14		B	12.21	7.92		B	12.14	7.59	
Physical Skill												
Balance Beam	A	27.41	2.44	3.49*	A	26.96	2.23	4.28*	A	27.09	2.18	4.24*
	B	24.86	3.45		B	24.25	3.77		B	24.39	3.69	
Balance Stick	A	29.13	4.51	1.79*	A	28.43	7.28	2.05*	A	28.52	7.38	1.95
	B	25.66	9.59		B	24.91	9.46		B	25.15	9.26	
40-ft. dash	A	3.19	.25	2.05*	A	3.22	.28	2.36*	A	3.21	.26	2.30*
	B	3.36	.41		B	3.40	.43		B	3.39	.43	
Grip Strength Right hand	A	29.96	7.69	4.01*	A	28.38	8.57	4.45*	A	28.84	7.89	4.57*
	B	22.90	7.76		B	21.52	6.61		B	21.77	7.34	
Grip Strength Left hand	A	27.07	7.78	3.54*	A	25.67	7.96	3.92*	A	26.07	7.95	4.02*
	B	20.74	7.89		B	19.48	7.64		B	19.72	7.57	
Trunk Flexion	A	16.34	6.87	.01	A	16.56	6.78	.25	A	16.37	7.03	.06
	B	16.32	6.95		B	16.16	7.06		B	16.29	6.85	
Trunk Extension	A	20.47	5.69	2.54*	A	18.50	6.24	.53	A	19.16	6.06	1.51
	B	17.35	5.31		B	17.90	4.90		B	17.46	5.09	
Shoulder Flexion	A	17.86	4.79	1.26	A	17.60	4.37	1.50	A	17.15	4.87	.57
	B	16.44	5.01		B	16.10	5.41		B	16.57	5.07	
Ankle Flexion Right	A	61.19	16.55	2.60*	A	59.06	15.79	2.76*	A	58.30	17.05	1.95
	B	52.75	13.28		B	51.31	12.55		B	52.56	12.11	
Ankle Flexion Left	A	57.74	11.54	2.18*	A	54.17	14.39	.89	A	53.58	13.83	.39
	B	51.08	14.00		B	51.69	13.05		B	52.49	13.68	

*Significant Difference.

[1]Above the mean group (N = 27)
[2]Below the mean group (N = 75)
[3]Above the mean group (N = 48)
[4]Below the mean group (N = 52)
[5]Above the mean group (N = 43)
[6]Below the mean group (N = 57)

TABLE 3

Mean Differences on Physical and Motor Skill Tests Between Fast and Slow Learning Boys

Tests	Ball Bounce				Ball Toss				Combined Score			
	Group	Mean	S.D.	t	Group	Mean	S.D.	t	Group	Mean	S.D.	t
Motor Ability-Educability												
Brace	A[1]	13.67	2.77	3.47*	A[3]	12.73	2.79	2.95*	A[5]	13.32	2.49	3.45*
	B[2]	10.69	2.72		B[4]	10.36	2.83		B[6]	10.53	2.87	
Iowa-Brace	A	17.73	4.14	3.14*	A	16.38	3.67	2.18*	A	16.79	3.68	2.23*
	B	14.19	3.35		B	14.04	3.86		B	14.31	3.80	
Carpenter	A	18.67	5.84	5.38*	A	14.04	5.88	1.83	A	16.95	6.17	4.35*
	B	9.78	5.02		B	10.68	6.96		B	9.69	5.31	
Physical Skill												
Balance Beam	A	27.87	2.31	4.38*	A	26.62	2.02	3.13*	A	27.00	2.41	3.13*
	B	24.42	2.59		B	24.20	3.26		B	24.50	2.86	
Balance Stick	A	30.01	5.18	2.98*	A	27.42	5.64	1.45	A	28.61	5.08	2.18*
	B	24.56	6.08		B	24.85	6.74		B	24.71	6.56	
40-ft. Dash	A	3.15	.22	1.31	A	3.17	.29	1.54	A	3.15	.29	1.60
	B	3.28	.35		B	3.31	.34		B	3.30	.33	
Grip Strength Right hand	A	32.47	8.59	2.92*	A	30.46	9.14	2.87*	A	32.37	8.96	3.57*
	B	24.92	8.09		B	23.68	7.24		B	24.03	7.32	
Grip Strength Left hand	A	29.40	8.39	2.47*	A	27.35	9.10	2.05*	A	29.00	8.84	2.72*
	B	23.17	7.89		B	22.56	7.11		B	22.63	7.36	
Trunk Flexion	A	17.81	6.23	.71	A	18.42	6.46	.43	A	17.16	5.82	1.41
	B	19.23	6.48		B	19.22	6.39		B	19.79	6.58	
Trunk Extension	A	21.13	6.19	1.77	A	19.00	6.67	.30	A	20.11	6.19	1.19
	B	17.74	6.10		B	18.46	5.92		B	17.92	6.25	
Shoulder Flexion	A	18.61	4.74	1.82	A	17.67	5.27	.49	A	18.17	4.89	.93
	B	16.79	4.97		B	16.96	4.62		B	16.82	4.95	
Ankle Flexion Right	A	62.60	16.59	3.35*	A	53.00	17.14	.25	A	58.63	16.33	2.31*
	B	48.25	12.24		B	51.92	12.72		B	48.81	13.09	
Ankle Flexion Left	A	55.60	11.98	2.37*	A	50.50	14.52	.82	A	55.53	12.73	2.86*
	B	46.22	12.91		B	47.40	11.81		B	45.09	12.14	

*Significant Difference.

[1]Above the mean group (N = 15)

[2]Below the mean group (N = 36)

[3]Above the mean group (N = 26)

[4]Below the mean group (N = 25)

[5]Above the mean group (N = 19)

[6]Below the mean group (N = 32)

TABLE 4

Mean Differences on Physical and Motor Skill Tests Between Fast and Slow Learning Girls

Tests	Ball Bounce				Ball Toss				Combined Score			
	Group	Mean	S.D.	t	Group	Mean	S.D.	t	Group	Mean	S.D.	t
Motor Ability-Educability												
Brace	A[1]	12.81	1.84	2.60*	A[3]	12.29	1.90	2.42*	A[5]	12.32	2.14	2.27*
	B[2]	10.48	3.27		B[4]	10.24	3.61		B[6]	10.37	3.43	
Iowa-Brace	A	17.13	2.71	3.01*	A	16.54	2.94	3.39*	A	16.32	2.91	2.68*
	B	13.15	4.81		B	12.44	5.04		B	12.93	5.18	
Carpenter	A	24.19	6.27	5.54*	A	21.96	6.60	5.56*	A	21.86	6.72	4.76*
	B	12.70	6.85		B	11.16	6.70		B	12.04	7.29	
Physical Skill												
Balance Beam	A	27.56	2.15	2.51*	A	27.21	2.33	2.94*	A	27.14	2.18	2.53*
	B	24.76	4.10		B	24.20	4.35		B	24.48	4.40	
Balance Stick	A	31.34	11.01	2.03*	A	31.53	10.97	3.14*	A	30.56	9.80	2.16*
	B	24.97	9.63		B	22.75	8.01		B	24.20	10.24	
40-ft. dash	A	3.23	.27	1.92	A	3.18	.25	3.86*	A	3.22	.25	2.60*
	B	3.46	.45		B	3.58	.44		B	3.52	.47	
Grip Strength Right hand	A	27.13	4.40	3.72*	A	27.21	5.13	6.41*	A	26.82	5.17	4.86*
	B	20.09	6.74		B	17.76	4.97		B	18.78	6.00	
Grip Strength Left hand	A	24.81	5.48	3.76*	A	25.04	5.39	6.85*	A	24.32	5.32	4.65*
	B	17.36	6.77		B	14.76	4.90		B	16.11	6.52	
Trunk Flexion	A	12.91	6.63	.61	A	12.55	6.48	1.26	A	13.40	6.27	.32
	B	14.14	6.33		B	14.88	6.22		B	14.01	6.60	
Trunk Extension	A	19.48	5.45	1.98	A	17.75	5.45	.18	A	19.12	5.18	2.08*
	B	16.73	3.90		B	17.50	3.71		B	16.41	3.74	
Shoulder Flexion	A	16.01	4.32	.28	A	16.91	4.37	.83	A	16.59	4.08	.36
	B	16.44	5.24		B	15.72	5.40		B	16.06	5.57	
Ankle Flexion Right	A	63.06	14.15	1.94	A	60.04	14.75	1.16	A	61.50	13.20	1.77
	B	55.09	12.78		B	55.44	12.32		B	54.59	13.43	
Ankle Flexion Left	A	61.44	9.31	1.70	A	60.96	11.83	2.18*	A	60.82	11.78	1.92
	B	54.76	13.94		B	53.08	12.90		B	53.78	13.09	

*Significant Difference.

[1]Above the mean group (N = 16)
[2]Below the mean group (N = 33)
[3]Above the mean group (N = 24)
[4]Below the mean group (N = 25)
[5]Above the mean group (N = 22)
[6]Below the mean group (N = 27)

Regression Equation

The regression equation was computed for the whole group. The equations are not so much for practical use as to show the relationship of the test battery to motor learning and the per cent contribution of the combined action of the independent variables in predicting the criterion.

A four-item test battery, consisting of the Carpenter, Grip Strength right, 40-ft. Dash, and Arm Forward 110° right, correlated .650 ± 6.75 with the combined motor learning score. The proportion of explained variance (R^2) indicated 42.2 per cent of whatever makes the boys and girls in the three grades differ in motor learning can be attributed to what is measured by the Carpenter, Grip Strength right, 40-ft. Dash and Arm Forward 110° right. The total contribution can be broken down further into independent contributions of each item in the battery: 18.8 per cent is the contribution of the Carpenter, 15.9 per cent is the contribution of Grip Strengh right, 6.5 is the contribution of the 40-ft. Dash and one per cent is the contribution of Arm Forward 110° right. The remaining 57.8 per cent of the variance can be attributed to factors not measured.

Inasmuch as a battery of fewer items would be desirable, the multiple correlations for a three-item battery and a two-item battery were calculated. The Arm Forward 110° right was deleted for the three-item battery, which correlated .648 ± 6.76 with the combined motor learning score. The proportion of explained variance (R^2) indicated 42.1 per cent of whatever makes children differ in motor learning can be contributed to what is measured in these tests.

The 40-ft. Dash was deleted to form the two-item battery, which correlated .611 ± 7.02 with the combined motor learning score. R^2 indicated that the per cent contribution of this combined action of the independent variables in predicting the criterion was 37.4. The independent contributions of the Carpenter was 21.4 per cent and of the Grip Strength right was 16 per cent. Thus, by the addition of the Grip Strength test to the Carpenter test, a 16 per cent improvement in predicting motor learning is gained.

The regression equations for the various test batteries were computed in score form. The results are as follows:

1. *Four-item battery.*
   $X_o = .410$ (Carpenter) + .366 (Grip Strength right) + 5.042 (40-ft. Dash) + .072 (Arm Forward 110° right) + 17.898
2. *Three-item battery.*
   $X_o = .419$ (Carpenter) + .374 (Grip Strength right) + 5.182 (40-ft. Dash) + 17.464
3. *Two-item battery.*
   $X_o = .468$ (Carpenter) + .368 (Grip Strength right) + 34.060

Conclusions

1. Many of the physical and motor ability measures differentiated significantly the fast and slow learners (as measured in this study).

2. A significant gain in learning occurred between the initial and final administration of the motor learning skill tests.

3. The boys were superior to the girls in learning the motor skills.

4. Of the tests designed to measure motor ability and educability, the Carpenter correlated highest with the motor learning criterion (r. 513). The addition of Grip Strength right to the Carpenter tests improves the prediction of motor learning 16 per cent.

5. An analysis of the multiple correlations indicates there are some physical traits and abilities which contribute toward motor learning (as measured in this study), but there are evidently many more. There is need for more research to determine the nature of the traits related to motor learning which were not included in this study.

REFERENCES

1. American Association for Health, Physical Education, and Recreation. National Research Council of the Research Section. *Measurement and Evaluation Materials in Health and Recreation.* Washington 6, D. C.: The Association, 1950.
2. Bovard, John F., Frederick Cozens and E. Patricia Hagman. *Tests and Measurements in Physical Education.* Philadelphia: W. B. Saunders Co., 1949.
3. Brace, David K. *Measuring Motor Ability.* New York: A. S. Barnes and Co., 1927.
4. Carpenter, Aileen. Tests of motor educability for the first three grades. *Child Development,* **11**: 293-299 (Dec. 1940).
5. Cureton, T. K. Flexibility as an aspect of physical fitness. *Research Quarterly,* **12**: 381-390 (May 1941).
6. Garrett, H. E. *Statistics in Psychology and Education.* New York: Longmans, Green and Co., 1938.
7. Lindquist, E. F. *A First Course in Statistics.* Boston: Houghton Mifflin Co., 1942.
8. ———. *Statistical Analysis in Educational Research.* New York: Houghton Mifflin Co., 1940.
9. McCloy, Charles H. *Tests and Measurements in Health and Physical Education.* New York: Appleton-Century-Crofts, Inc., 1942.
10. Scott, M. Gladys, and Esther French. *Evaluation in Physical Education.* St. Louis: The C. V. Mosby Co., 1950.
11. Seashore, Harold G. The development of a beam-walking test and its uses in measuring development of balance in children. *Research Quarterly,* **18**: 246-259 (Dec. 1947).
12. Smith, Jean A. *The Relation of Certain Physical Traits and Abilities to Motor Learning in Elementary School Children.* Unpublished Doctor's thesis, School of Health, Physical Education, and Recreation, Indiana University, Bloomington, 1953.
13. Stevens, Mildred. *The Measurement of Kinesthesis in College Women.* Unpublished Doctor's thesis, School of Health, Physical Education, and Recreation, Indiana University, Bloomington, 1950.

(Submitted 6/20/55)

Relationship of Occupancy and Adequacy of Student Housing to Incidence of Acute Upper Respiratory Conditions

WESLEY M. STATON
Wayne University[1]
Detroit, Michigan

Abstract

Three hundred twelve college students were observed for 60 days to determine the incidence of acute upper respiratory conditions. Students were grouped on the basis of (a) the number of persons sharing the sleeping room and (b) the size of the room. Diagnosis and case reporting were carried out by university staff physicians. Critical ratios were obtained to determine the significance of the differences in the incidence of otolaryngologic conditions between groups. Analysis of the data indicated that inadequacy of floor space is a more influential factor in upper respiratory illness than is the number of persons sharing a room.

THE CAUSATIVE relationship between poor housing and the incidence of communicable diseases has long been recognized (1, 3, 4, 14, 15, 20, 21). Prominent among the infections exhibiting a significantly higher prevalence in the locales of hygienically undesirable housing are those which affect the upper respiratory tract (4, 5, 9). Necessarily then, the provision of healthful housing for college students is a pre-eminent consideration for administrators and health personnel in institutions of higher education (17, 19).

While the close relationship between crowded conditions of housing and the incidence of otolaryngologic pathologies is a point of rather general agreement, there are few data affording objective evidence of the precise influences germane to this association. Beyond the paucity of analytical studies of pertinent causal relationships, there are evidences of inconsistency with regard to certain specific aspects of the broad relationship.

An investigation conducted by Barrow (2) at Stanford University revealed that the incidence of the common cold among college students was not significantly altered by the sleeping room conditions of the subjects. A more recent study of students at the Phillips Exeter Academy tended to strengthen the rationale of the constitutional hypothesis by disclosing rather significant individual patterns of susceptibility to acute coryza among subjects exposed to the same environment (18). However, Robertson and his co-workers (16)

[1]At the time of this study, the author was a faculty member of the University of Florida, Gainesville.

furthered the environmental postulate when they reported a direct relationship between the bacterial content of the air and the number of troops quartered in Army barracks. The fact that overcrowding of barracks resulted in significant increase in the incidence of acute diseases of the upper respiratory tract strongly suggests the importance of sleeping room conditions as an etiologic factor. In a recent review and analysis of research on the epidemiology of upper respiratory tract infections, Hodges (11) concluded that the amount and intimacy of close physical contact between individuals appear to be of significance in transmission of disease.

Although the studies of Barrow (2) and Sargent, *et al.*, (18) dealt with the common cold as a pathologic entity, it may be assumed that the conclusions advanced have application in the causal analysis of associated acute infections of the upper respiratory tract. The close inter-relationship holding between acute coryza and other acute pathologies of the otolaryngologic zone is generally recognized (7, 9).

Accordingly, in view of the somewhat contradictory evidence presented, and in consideration of the need for further study of the hygienic aspects of college housing (13) it was decided that experimental investigation of a phase of the total problem might shed more light on the question.

Purpose of the Study

The central purpose of this investigation was to determine the influence of sleeping room conditions on the incidence of acute infections of the upper respiratory tract among male college students.

Procedure

In order to determine the inter-relationship between sleeping room conditions and the incidence of otolaryngologic infection, two specific factors were chosen for experimental consideration. These factors were (a) the size of the sleeping room, in terms of square feet of floor space per person, and (b) the number of persons regularly using the sleeping room. These two components of student housing were considered to be among the more significant environmental elements pertinent to acute infection of the upper respiratory tract. Also, these factors could be readily appraised and adequately defined in the collection of data.

Subjects for the study included 312 male university students ranging in age from 17 to 29 years, with a median age of 19. Each subject completed a medical history form reporting all data relating to the pre-existence of chronic otolaryngologic conditions, presence of tonsils and adenoids, extent of smoking, immunizational status, and other pertinent health information. None of the subjects had received influenza inoculations. Subjects whose health histories showed the existence of a chronic disease of the upper respiratory tract were eliminated from participation in the study. Tonsillectomized and adenoidectomized individuals were included, since it could be assumed that they were randomly distributed among the several classes of

sleeping room situations. Moreover, the relationship between tonsil and adenoid removal and the incidence of otolaryngologic infection is not yet established (12).

The 312 subjects were classified into five separate groups on the basis of the number of persons regularly using the sleeping room. Since the subjects were selected on a voluntary basis, it was not possible to secure equal numbers in the several types of sleeping room situations considered. The five groups indicated room occupancy as follows: group I, *one* occupant; group II, *two* occupants; group III, *three* occupants; group IV, *four* occupants; and group V, *five* or more occupants. Of the 312 subjects, 42 were classed in group I; 159 in group II; 46 in group III; 40 in group IV; and 25 in group V.

In order to determine the influence of crowding on the incidence of acute upper respiratory tract infection, a second classification was made in terms of the number of square feet of floor space per occupant. On the basis of the criterion established by the Committee on the Hygiene of Housing of the American Public Health Association (1), the size of the sleeping room was categorized as being *adequate* or *inadequate*. Subjects whose sleeping quarters afforded 50 square feet, or more, of floor space per person were considered to be enjoying adequate sleeping room conditions. Those whose sleeping environment did not meet this standard were considered to be living in inadequate housing insofar as sleeping room size was concerned. Of the total sample, 232 were classed as being in adequate quarters and 80 as being in inadequate sleeping environs.

Each subject received mimeographed data instructing him to report immediately to the university infirmary if, at any time during the 60-day experimental period, he experienced one or more of the described signs and/or symptoms of acute upper respiratory infection. These instructions were prepared in collaboration with staff physicians of the University of Florida's Department of Student Health. Subjects reporting to the infirmary during the investigational period, including the months of April and May, were examined by staff physicians who prepared a comprehensive diagnostic report for each case. The data reported were based upon clinical diagnoses since laboratory analyses were not conducted. It was recognized that certain of the upper respiratory infections, such as the common cold and influenza, do not always present well-defined clinical entities (6, 7, 9, 15). However, within the broad scope of acute otolaryngologic conditions, the diagnoses for this study could be assumed to have validity.

Results

Following the diagnostic and case-reporting phase of the study, the accumulated reports were classified and tabulated according to the incidence of infection among the various groups previously described. The distribution of cases and the percent incidence with respect to room occupancy, or multiplicity of contact, are shown in Table 1.

TABLE 1

Comparative Incidence of Acute Upper Respiratory Infection in Relation to Sleeping Room Occupancy

Group	Room occupancy	Total number	Number of cases	Percentage of cases	$\sigma\%$
I	1	42	2	4.8	3.3
II	2	159	2	1.3	.9
III	3	46	6	13.0	5.0
IV	4	40	7	17.5	6.0
V	5+	25	1	4.0	3.9

On the basis of these data, the reliabilities of the differences between percentages were determined by calculating critical ratios according to appropriate formulae (8). Inter-group comparisons in terms of t values disclosed significant differences in percent incidence of infection existing between groups II and III at the .05 level of confidence, and between groups II and IV at the .01 level of confidence. It is noteworthy that subjects in groups III and IV were more often found to be sleeping in rooms having inadequate space than were subjects in other groups. Statistically insignificant differences between groups I, II, and V, and the significant differences between II and III and II and IV, tend to indicate that adequacy is a more influential factor than is occupancy. However, since the use of standard error of percentages may be of questionable validity when small samples are combined with an extreme percentage, it is probably advisable to regard the two instances of significant intergroup differences with caution.

Classification of the data with respect to the influence of per capita sleeping room space on the incidence of infection probably affords more meaningful comparison. Morbidity rates for groups A (adequate) and B (inadequate) are presented in Table 2.

TABLE 2

Comparative Incidence of Acute Upper Respiratory Infection in Relation to Per Capita Sleeping Room Space

Group	Per capita space	Total number	Number of cases	Percentage of cases	$\sigma\%$	$\sigma D\%$	t
A	$>$ 50 sq. ft.	232	8	3.5	1.2		
B	$<$ 50 sq. ft.	80	10	12.5	3.7	3.9	2.31

The evidence in Table 2 indicated a significant difference existing between the incidence of acute otolaryngologic infection among subjects in adequate quarters and among those in inadequate quarters. That is, the rate of infection was significantly higher among students whose sleeping rooms provide less than 50 square feet of floor space per person.

Conclusions

On the basis of the obtained data, and within the limitations of the techniques used, the following conclusions would seem justifiable for similar population samples:

1. The amount of floor space per person in a sleeping room appears to have a significant relationship to the incidence of acute otolaryngologic infection. The difference observed between groups A and B is significant at the .05 level of confidence.

2. The lack of a common pattern of significant differences obtaining between any groups when classified in terms of the number of room occupants would seem to indicate that this factor, as such, is not a prominent etiologic element.

3. There is a tendency toward overcrowding when three or four students share a sleeping room. This would appear to reflect the practice of three or four persons using a room designed primarily for two people. When students sleep five or more in a room, this room is generally of the sleeping porch type and designed for relatively larger numbers of occupants.

REFERENCES

1. American Public Health Association, Committee on the Hygiene of Housing, *Basic Principles of Healthful Housing.* New York: the Association, 1950.
2. Barrow, cited by Diehl, H. S., *Textbook of Healthful Living.* New York: McGraw-Hill Book Co., 1950, p. 286.
3. Britten, R. H., Housing and Health, *Am. J. Pub. Health,* **28:** 957, 1938.
4. ———, New Light on the Relation of Housing to Health, *Am. J. Pub. Health,* **32:** 193, 1942.
5. Collins, S. D., F. R. Phillips and D. S. Oliver, Causes of Illness Recorded in Monthly Canvasses, *Pub. Health Rep.,* **65:** 1235, 1950.
6. Dingle, J. H., et al., A Study of Respiratory Infections in Families, *Tr. A. Am. Physicians,* **62:** 99, 1949.
7. Dochez, A. R., The Bearing of Investigations of Acute Respiratory Infection on Public Health, in Simmons, J. S. (editor), *Public Health in the World Today.* Cambridge, Mass.: Harvard University Press, 1949.
8. Garrett, H. E., *Statistics in Psychology and Education.* New York: Longmans, Green and Co., 1947.
9. Hanger, F. M., The Common Cold, in Cecil, R. L. (editor), *A Textbook of Medicine.* Philadelphia: W. B. Saunders and Co., 1951.
10. Hodges, R. G., Epidemiology of Upper Respiratory Tract Diseases, *J. A. M. A.,* **147:** 1335, 1951.
11. Kaiser, A. D., Tonsils and Adenoids, in Grulee, C. G., and R. C. Eley, *The Child in Health and Disease.* Baltimore: The Williams and Wilkins Co., 1952.
12. Keys, A., Research in Student Health, in *A Health Program for Colleges.* New York: National Tuberculosis Association, 1947.
13. Marquette, B., Relationships Between Housing and Health, *Pub. Health Rep.,* **55:** 74, 1940.
14. New York Academy of Medicine, Committee on Public Health. *Preventive Medicine in Modern Practice.* New York: The Academy, 1942.
15. Richards, D. W., Bronchitis, in Cecil, R. L. (editor), *A Textbook of Medicine.* Philadelphia: W. B. Saunders and Co., 1951.

16. Robertson, O. H., et. al., A Study of the Nature and Control of Airborne Infection in Army Camps, *J. A. M. A.*, **126**: 993, 1944.
17. Sander, I. W., Sanitation, Housing and Nutrition, in *A Health Program for Colleges*. New York: National Tuberculosis Association, 1947.
18. Sargent, F., O. M. Lombard and V. W. Sargent, Further Studies on Stability of Resistance to the Common Cold, *Am. J. Hygiene*, **45**: 29, 1947.
19. Second National Conference on College Hygiene. *Health in Colleges*, Proceedings of the Conference. New York: National Tuberculosis Association, 1937.
20. Shephard, W. P., et al., *Essentials of Public Health*. Philadelphia: J. B. Lippincott Co., 1952.
21. Smillie, W. G., *Preventive Medicine and Public Health*. New York: The Macmillan Co., 1952.

(Submitted 7/22/55)

Comparison of Two Methods of Teaching Beginning Basketball[1]

PEGGY P. WHILDEN
University of Maryland
College Park, Maryland

Abstract

In this study, two methods of teaching beginning basketball were compared—one pupil-dominated and the other teacher-dominated. Two physical education classes totaling 75 seventh-grade girls were used as subjects. Comparison of the two groups was on the basis of group dynamics as measured by sociometric tests, the quality of performance in competition, and finally the scoreboard status of the two groups when competing against each other. It was found that the pupil-dominated technique had certain advantaegs in terms of bringing least-liked individuals into the group and in terms of improving some aspects of team performance.

A STUDY WAS conducted to compare two methods of teaching beginning basketball to junior high school girls.[2] One method involved a maximum of pupil participation in planning, decision making, and controlling of play; the teacher playing the part of consultant and adviser after an initial period of basic skills and rules instruction. In the second method, the teacher assumed full responsibility for planning and criticizing stratagem, group discipline, and officiating.

Comparison of the two groups was on the basis of group dynamics as measured by sociometric tests, and quality of performance in competition as rated by unbiased observers. The scoreboard status of the two groups when competing against each other was used as a further comparison.

Limitations

1. The researcher attempted to compensate for a frank personal bias in favor of the method involving a maximum of pupil thinking and decision making by: (a) utilizing objective tests and unbiased observers as the means of comparing the groups before and after the experiment, and (b) attempting to do the best possible teaching when working with both groups (in this regard, the past experience of the researcher qualified her for the method in which the teacher dominated most of the situation rather than for the method involving a maximum of pupil participation).

2. A systematic equating of the two groups was not possible because of the school schedule to which the study had to conform. However, comparative

[1]This study was made in partial fulfillment of the requirements for a Master of Arts degree, University of Maryland, June 1954, under the direction of Dr. Dorothy Deach and Dr. Warren R. Johnson, College of Health, Physical Education, and Recreation.

[2]The study was conducted in Washington, D. C., during the fall semester of 1952, for 16 class periods over an eight-week period.

data on grade level, mental age, basketball knowledge, and sociometric status indicated that the two groups were actually comparable.

3. The school schedule also dictated the time and days when the study could be conducted.

Procedure

Two seventh-grade physical education classes composed of 37 and 38 girls respectively were utilized as the pupil-dominated and teacher-dominated groups. The group in which the maximum of pupil participation was encouraged was arbitrarily designated the pupil-dominated grouup. The group which was subjected to the more intensive domination by the teacher was designated as the teacher-dominated group.

EQUATING OF GROUPS

Available data and tests given showed the two groups to be comparable in terms of the following:

1. *Grade level.*
2. *Chronological age.*
3. *Mental age.* Upon entering the seventh grade, the students are grouped homogeneously by the school in terms of mental age (Quick Scoring Otis Test), and are placed in classes according to the test results. The two groups in this study were classified as average by the school. The basic data were not made available to the researcher.
4. *Basketball Knowledge.* Each student was given a short practical test on shooting and dribbling a basketball, and asked whether she had played basketball before, and if so, where and how long. In the pupil-dominated group, one student had played a few times in a recreation center. The teacher-dominated group had two students who had played a little basketball in a recreation center.
5. *Motor Ability.* The motor ability test used in this study included the Dash, Wall Test, and Jump and Reach (23, *pp. 140-148*).

FORMING OF TEAMS

TABLE 1
Data Used in Equating the Two Groups

Group	Grade level	Age	Mental age	Basketball knowledge	Motor Ability		
					Dash	Wall Test	Jump and Reach
Pupil-dominated	7th	12-13 yrs.	100-110	no previous instruction or play	M = 19.45 SD = 1.92	M = 11.59 SD = 2.21	M = 8.92 SD=2.68
Teacher-dominated	7th	12-13 yrs.	100-110	no previous instruction or play	M = 19.46 SD = 1.95	M = 11.62 SD = 2.26	M = 8.89 SD=2.63*

*The formula used for the standard deviation was: $SD = \frac{\sqrt{E X^2}}{N} - M^2$ (17, *p. 168*).

Both groups were formed into teams on the basis of findings from McCloy's Classification Index I[3] (20, *p. 46*), and the findings from a sociometric test.

TABLE 2
Sociometric Test Results
(Test I)

	Number of Girls			
Pupil-dominated	Well-liked	Liked	Rejected	Near-isolated
Team 1	2	2	2	3
Team 2	3	1	1	4
Team 3	2	1	2	4
Team 4	3	2	2	3
Total	10	6	7	14
Teacher-dominated				
Team 1	2	4	0	3
Team 2	2	4	1	3
Team 3	2	4	1	3
Team 4	2	4	1	2
Total	8	16	3	11

Both facts were taken into account in order to distribute physically comparable subjects equally throughout the teams, and to distribute approximately equal numbers of well-liked, liked, rejected, and near-isolated girls on each team; this classification was developed as a result of the sociometric test.

PRE-EXPERIMENT TESTING

A sociometric test was administered to both groups at the beginning of the experiment. The questions asked were: (1) Name five girls in this class whom you would most like to have on your team; (2) Name five girls in this class whom you would least like to have on your basketball team; (3) Name five girls in this class whom you would most like to have as friends, whom you would invite to your home; (4) Name five girls in this class whom you would least like to have as friends (3, *p. 76*).

Information derived from this test was used: (1) as a factor in determining the membership of teams, and (2) as a basis for comparison of group status of the groups before and after the experiment. As a result of the sociometric test results, the girls in both classes were put into four classifications, arbitrarily, as follows:

plus one sigma and above = well-liked
the mean to plus one sigma = liked
the mean to minus one sigma = near-isolated
minus one sigma and below = rejected

The standard deviation was found for each of the two criteria in the test, skill and friendship, each time the sociometric test was given.[4]

[3]The formula used was: 20(age) + 6(height) + weight.

[4]The skill question was asked only in order to compare the results with the friendship question.

TEACHING PROCEDURES

At the beginning, both groups were taught the rules, fundamental skills, and basic tactics of basketball. Neither group was told about the experiment. The different teaching techniques were put into effect the seventh class period, at which time the two groups were divided into four teams each, with nine girls on each team.

1. *The method of instructing the pupil-dominated group.* At the seventh class period, the pupil-dominated group was put completely on its own. The teacher served as consultant, and usually only at the request of the students. Each team had to plan its own plays and do its own substituting. Every girl playing was responsible for raising her hand when she committed a foul; a girl at the sidelines blew a whistle when she saw a hand go up, and the girl who had fouled then named the foul and the appropriate penalty. The two teams not playing were responsible for the time- and score-keeping jobs; those teams were also responsible for having two girls at the sidelines to act as "referees" and blow their whistles when they saw a hand raised, to place the ball after the foul had been named, and to toss for a tie ball. Also the teams not playing were to write down fouls not called or called incorrectly. In the post-game evaluations, those fouls missed were discussed.[5]

2. *The method of instructing the teacher-dominated group.* The teacher-dominated group was completely under the control of the teacher. The refereeing, substituting, planning of plays and coaching were all done by the teacher. This group was never left on its own. The two teams not playing were told to watch the plays and fouls made, and to see why the fouls were committed.[6]

FINAL EXPERIMENT TESTING

1. *Evaluation of performance.* In order to compare the two groups in the quality of performance in competition, they were tested in two ways:

(a) Four unbiased observers independently rated the pupil-dominated and teacher-dominated groups. The observers were not told about the experiment, but only instructed to rate each group according to the rating sheet. This rating took place during the 15th class period.

(b) Inter-group game situation. These games were for the purpose of observing the quality of performance produced in terms of the scoreboard; that is, the pupil-dominated teams played the teacher-dominated teams. These games were held after school after the 16th and last class period.

2. *Evaluation of sociometric status.* At the end of the experiment, the sociometric test was again administered to determine whether there had been any change in the group status of the groups during the course of the experiment.

---

[5]After the games had started, the teams not playing, without any suggestion from the teacher, decided to see which team could find the most fouls not called during that period.

[6]Some of the girls did as they were told, but others played tag or talked and had to be constantly called down.

Results

QUALITY OF PERFORMANCE

1. *The unbiased observers.* The four observers (three had their National Rating in basketball, and the fourth was the Junior High School Physical Education Supervisor) were each given a rating sheet for each game in the two groups. They were instructed to rate each game on a five scale basis; each scale was from 0 to 9 (from very poor to excellent). The scales were as follows: Scale A—basic skills; Scale B—knowledge of the rules; Scale C—performance as a team; Scale D—behavior on the floor; and Scale E—over-all rating of quality of performance.

In order to get a composite rating for each of the two teaching methods, the ratings of the two games under each method were combined.

TABLE 3

A Summary of the Ratings of the Observers Who Watched Play in Progress

Rating Scale	Pupil-Dominated	Teacher-Dominated
Scale A	5.8	6.3
Scale B	6.6	4.5
Scale C	6.2	5.7
Scale D	6.8	6.8
Scale E	6.8	6.1
	Mean = 6.4	Mean = 5.9

The teacher-dominated group received a higher rating on basic skills, while the pupil-dominated group was rated higher in knowledge of the rules, performance as a team, and over-all quality of performance.

Some of the comments from the observers were as follows:

(a) The pupil-dominated group was too "rule conscious."

(b) The teacher-dominated group seemed to enjoy the game; while the pupil-dominated group appeared too self-conscious.

(c) The teacher-dominated group appeared to handle the ball better than the pupil-dominated group.

2. *Reaction of each group to a different situation.* During the 15th class period, the pupil-dominated group switched over to the method that the teacher-dominated group had used; that is, officials were used in the customary manner (this game was after the rating period). It was found that these pupils were able to make the change very quickly and easily. An effort was also made to see if the teacher-dominated group could switch over to the method that the pupil-dominated group had used. It was found that they were unable to make the change, game rules were ignored, and team organization soon disappeared entirely. However, it should be pointed out that while the non-referee situation was completely new to the teacher-dominated group, the pupil-dominated group, though they had been conditioned to a new technique, had watched refereed games prior to the experiment, so the experience of working with a referee could not be considered as completely unfamiliar to them.

3. *Inter-group competition score results.* The pupil-dominated group teams played the teacher-dominated group teams for a scoreboard criterion of skill with the following results: the pupil-dominated group won three games out of four with a sum total of 31 points; while the teacher-dominated group won one game out of four with a sum total of 16 points.

SOCIOMETRIC STATUS RESULTS

The ISI and GCS formulas were used as one of the methods in analyzing the sociometric data (6, *p. 96*). The Individual Status Index derives an over-all status rating for each person in a group; while the Group Cohesion Score is an over-all status rating for the group as a whole. The formulas are:[7]

$$ISI = \frac{TC - TR}{N - 1}; \quad GCS = \frac{TC - TR}{N(N - 1)}.$$

1. *GCS results.*

TABLE 4

Results of the Sociometric Status Before the Experimental Basketball Unit (Test 1) in Comparison with Status After the Basketball Unit (Test 2)

Friendship Criterion							
Pupil-Dominated Group				Teacher-Dominated Group			
Test 1		Test 2		Test 1		Test 2	
GCS Results	Mean of GCS	GCS Results	Mean of GCS	GCS Results	Mean of GCS	GCS Results	Mean of GCS
.08	2.76	.09	3.16	.11	3.95	.10	3.84
Skill Criterion							
Pupil-Dominated Group				Teacher-Dominated Group			
Test 1		Test 2		Test 1		Test 2	
GCS Results	Mean of GCS	GCS Results	Mean of GCS	GCS Results	Mean of GCS	GCS Results	Mean of GCS
.05	1.89	.08	2.81	.10	3.82	.09	3.47

Summary of GCS results. According to Table 4, in the friendship criterion, the pupil-dominated group showed an increase of one degree in the group feeling; while the teacher-dominated group showed a decrease of one degree. In both groups, the change of one degree was not significant.

The skill criterion, though it was tested only for a comparison of results with the friendship criterion, showed an increase of three degrees in the group feeling of the pupil-dominated group; while the teacher-dominated group showed a decrease of one degree.

2. *ISI results.*[8] The ISI results were put on bar graphs, which showed the number of girls in each group at the beginning and end of the experiment in

[7]TC = Total choices; TR = Total rejections; N = Number of persons in the group.

[8]It was apparent from the structure of the sociograms that the two groups had undergone changes only in relation to the individuals near the peripheral of the sociograms. Therefore, the only significant changes occurred to the individuals in the near-isolated classification, so statistical treatment did not seem appropriate.

each of the four classifications (well-liked, liked, near-isolated, and rejected). Since the results are the same as on the sociograms, they will not be mentioned here.

3. *Sociograms.* The sociograms were constructed in circular patterns, in order to portray the group status of the pupil-dominated and teacher-dominated groups at the beginning and end of the experimental period. At the end of the experimental period, the following results were obtained from both groups:

TABLE 5

Number of Girls in Each of the Four Classifications at the Beginning and End of the Experimental Period

Classifications	Pupil-Dominated		Teacher-Dominated	
	Test 1	Test 2	Test 1	Test 2
Well-liked	10	11	8	6
Liked	6	13	16	12
Near-isolated	14	7	11	19
Rejected	7	6	3	1
Total	37	37	38	38

Summary of sociograms. Inspection of the sociograms showed that in the pupil-dominated group, the near-isolated group had made a movement towards the center of the circle or liked group. On the other hand, the teacher-dominated group showed that there was a gathering towards the near-isolated group, or next to the outer circle. The well-liked and rejected groups had only one and two changes in both groups.

Conclusions

Within the limitations of this study, there seem to be certain advantages in the pupil-dominated approach, both in terms of team performance and in terms of individual changes in the sociometric structure.

1. The pupil-dominated technique appeared to be more effective than the teacher-dominated technique in improving the status of the near-isolated girls.

2. While the teacher-dominated group exhibited better command of the basic skills, as rated by unbiased observers, the pupil-dominated group showed greater knowledge of the rules, performed better as a team, and won three games out of four played against their teacher-dominated group opponents.

REFERENCES

1. Bonney, Merl E., A Study of the Sociometric Processes Among Sixth Grade Children, *Journal of Educational Psychology*, **37**: 359-372, 1946.
2. ———, Personality Traits of Socially Successful and Socially Unsuccessful, *Journal of Educational Psychology*, **34**: 449-472, Nov. 1943.
3. Breck, Sabina June, A Sociometric Measurement of Status in Physical Education Classes, *Research Quarterly*, **21**: 75-82, May 1950.

4. Bronfenbrenner, Urie, A Constant Frame of Reference for Sociometric Research, *Sociometry*, **7**: 40-75, Feb. 1944.
5. Cook, Lloyd A., An Experimental Sociographic Study of a Stratified Tenth Grade Class, *American Sociological Review*, **10**: 250-260, April 1945.
6. ———, Manual for Obtaining, Analyzing, and Diagramming Sociometric Data. Detroit: College Study in Intergroup Relations, 1950. 110 pp.
7. Cowell, Charles C., Physical Education as Applied Social Science, *Education Research Bulletin*, **16**: 147-155, Sept. 1937.
8. Criswell, Joan, Social Structure Revealed in a Sociometric Retest, *Sociometry*, **2**: 69-75, Oct. 1939.
9. Horace Mann Institute of School Experimentation. *How To Construct a Sociogram*. New York: Bureau of Publications, Teachers College, Columbia University, 1950. 37 pp.
10. Jennings, Helen Hall, *Leadership and Isolation*. New York: Longmans, Green and Co., 1943. 94 pp.
11. ———, *Sociometric in Group Relations*. D. C.: American Council on Education, 1948. 85 pp.
12. ———, Sociometry of Leadership, *Sociometry Monographs*, No. 14. New York: Beacon House, 1947. 28 pp.
13. ———, The Structure of Leadership and Sphere of Influence, *Sociometry*, **1**: 99-143, July-Oct. 1937.
14. Johnson, Warren R., Physical Education and the Learning Process, *Progressive Physical Educator*, pp. 14-17, Dec. 1950.
15. Kozman, Hilda C., editor, *Group Process in Physical Education*. New York: Harper and Bros., 1951. 418 pp.
16. Lewin, Kurt, and Ronald Lippitt, An Experimental Approach to the Study of Autocracy and Democracy, *Sociometry*, **1**: 292-300, Jan.-April 1938.
17. Lindquist, E. F., *A First Course in Statistics*. New York: Houghton Mifflin Co., 1942. 242 pp.
18. Lippitt, Ronald, and R. White, An Experimental Study of Leadership and Group Life, *Readings in Social Psychology*. New York: Henry Holt Co., 1947, 672 pp.
19. McCandless, Boyd Rowden, Changing Relationships Between Dominance and Social Acceptability During Group Democratization, *American Journal of Orthopsychiatry*, **12**: 529-535, July 1942.
20. McCloy, C. H., *Tests and Measurements in Health and Physical Education*. New York: Appleton-Century-Crofts, Inc., 1939. 412 pp.
21. Moreno, J. L., *Who Shall Survive? A New Approach to the Problem of Human Interrelations*, D. C.: Nervous and Mental Disease Publishing Co., 1934. 437 pp.
22. Newstetter, W. I., M. J. Feldstein, and T. M. Newcomb, *Group Adjustment*. Ohio: School of Applied Social Sciences, Western Reserve University, 1938. 154 pp.
23. Scott, Gladys M., and Esther French, Better Teaching Through Testing. New York: A. S. Barnes and Co., 1945. 247 pp.
24. Skubic, Elvera, A Study in Acquaintanceship and Social Status in Physical Education Classes, *Research Quarterly*, **20**: 80-87, March 1949.
25. Todd, Frances, Sociometry in Physical Education, *Journal of American Association for Health, Physical Education, and Recreation*, **24**: 23, May 1953.
26. ———, *Democratic Methodology in Physical Education*. Unpublished Doctoral dissertation, Stanford University, Calif., 1951. 243 pp.

(Submitted 9/9/55)

Notes & Comments

NOTES

Evaluation of Physical Education in North Carolina High Schools

NATHAN TAYLOR DODSON
State Department of Public Instruction
Raleigh, North Carolina

THE HEALTH AND Physical Education Score Card No. II, developed by a committee on curriculum research of the College Physical Education Association, was used to score 135 North Carolina high schools as part of a recent national survey of physical education. The schools were selected by a stratified, proportional random sample technique and were visited and scored by a trained observer after conferences with both principals and physical education teachers.

Total scores made by North Carolina schools ranged from 32-201, with a mean of 91.38. The median score was 76 points. Analysis of the relationship between total score and various factors such as geographical area of the state, school size, town size, and accreditation by the Southern Association of Colleges and Secondary Schools revealed that total score did not vary significantly from one section of the state to another. The other factors of accreditation, school size, and town size were all significantly related in the order mentioned to both area score and total score. This order of relationship was confirmed by the three statistical techniques, correlation, causal analysis, and ratio of means, which were used in the study.

The total score median of 76 made by North Carolina schools corresponded exactly with the national median based on preliminary returns from 17 states. This score represents less than 30 per cent of the total score possible.

Mean area scores by rank order were found to be Area IX, Organization and Administration of Class Programs, 13.57; Area VII, Medical Examinations and Health Service, 13.04; Area II, Outdoor Areas, 11.97; Area X, Administration of Intramural and Interscholastic Athletic, 10.95; Area III, Indoor Areas, 10.08; Area I, Program of Activities, 9.59; Area VI, Suplies and Equipment, 8.67; Area IV, Locker and Shower Areas, 8.41; Area VIII, Modified-Individual (corrective) Activities, 2.50; Area V, Swimming Pools, .97. It may be readily seen that Area V, Swimming Pool, is non-existent in North Carolina. Area VIII Corrective Activities, was not much better. These two areas of the score card have the same rank nationally, however.

The first place position of Area IX, Administration of the Class Program, is found also in the national average of 13.62 as compared to North Carolina's 13.57. Area X, Intramural and Interschool Athletics, ranked second nationally with a mean of 13.14 and fourth in North Carolina with a mean of 10.95.

It is to Area VII, Medical Examination and Health Service, that North Carolina can point with a little pride. Ranking second in North Carolina with a mean of 13.04, it ranks fourth nationally with a mean of 10.98. This favorable position can, no doubt, be attributed substantially to the expenditure of $550,000.00 annually for school health services.

Some of the items contained under Area VII include full, part-time, or volunteer service of a physician for medical examining, advisory, and emergency service; service of a trained nurse; a comprehensive medical examination by a physician; no participation in strenuous class or athletic activity without a satisfactory medical examination; and a permanent, continuous, progressive health record for each child as a basis for advice and follow-up health service. Other items under this area of Health Service cover classification for physical education on the basis of the medical examination; assignment

to rest or to restricted or individual activity approved by physician and physcial education teacher; health inspection of students returning to school following serious illness; health examination of teacher applicants; and non-medical teachers or school officers not being permitted to diagnose or treat health disorders.

Examination of score card items in terms of the person responsible for initiating change revealed that 11 items were the teacher's sole responsibiilty, 43 items were joint responsibility, and 46 were administrative responsibility. Analysis of relative effectiveness of personnel revealed that teachers were 26.7 per cent effective on their 11 items, those items of joint responsibility were achieved 29.5 per cent effectively, and the administrator was 30.5 per cent effective. These data point up the basic need of more active teachers where their own and joint responsibility are concerned.

TABLE 1

Health and Physical Education Item Priority List for North Carolina

Number	Item	Mean	Responsibility*
I-5	Course of study on file	.289	T
VI-6	Laundry of uniforms and towels	.370	B
IV-10	Sanitation of showers	.422	B
III-9	Instructor's office	.474	A
IV-3	Lock protection	.474	A
I-1	Broad program	.504	T
VI-5	Towels furnished	.541	B
IX-9	Health instruction yearly	.548	A
II-3	Court areas marked	.570	B
VI-4	Students wear uniform	.585	B
X-6	Girls coached by women	.585	B
II-10	Play area lighted	.630	A
VI-2	Individual sports equipment	.630	B
X-4	Sports days with carryover	.689	B
III-7	Faculty rest rooms	.696	A
IV-8	Hot water and soap	.704	A
VI-9	Piano or record player	.733	A
I-10	Faculty recreation encouraged	.741	B
III-8	Equipment office provided	.748	A
IV-7	Adequate shower space	.756	A
VI-10	Supplies used by community	.778	B
VIII-10	Modified activity temporarily	.800	B
IV-2	Individual lockers	.837	A
II-5	Jumping pits	.844	B
X-3	Woman teacher for girls	.852	B
IV-9	Toilet facilities	.911	A
IV-1	Adequate locker space	.933	A
IX-7	Comprehensive testing program	.941	T
X-5	Noon hour activity	.948	B
IX-2	Teachers active professionally	.956	T
VII-7	Assignment to individual activity	.956	B
I-3	Daily participation by all	.978	A
IV-4	Supervision of locker area	.985	T
I-4	Intramural program	.993	B

*A—Administrator, T—Teacher, B—Both or joint responsibility.

Table 1 shows the 34 items that were judged to have the most potential for improving the total score of North Carolina schools on the health and physical education score card. These items ranked low by mean item score, but were effective in discriminating between high and low scoring schools. Five of these items are the teacher's responsibility, 13 are the administrators, and 16 are joint responsibilities. Many of the administrator items are related to facilities and will be corrected only by new buildings or modifications of existing ones.

High ranking items were, for the most part, those required by state regulation. Schools in general did not allow substitution of other activity for physical education. Coaches and physical education teachers were certificated to teach in the state and had had training or experience in physical education. Low-ranking items were those in the areas of aquatics and correctives. Programs were limited in scope, being confined mostly to a few team games. Carry-over sports are lacking. Many girls classes were taught by men and most girls teams were coached by men.

COMMENTS

Observations Regarding Elvera Skubic's Study, "Emotional Responses of Boys to Little League and Middle League Competitive Baseball," *Research Quarterly*, 26: 342-352 (Oct. 1955).

MY INTENTION in these observations is to point up the necessity for readers to interpret with great caution all studies related to such highly complex and poorly understood subjects as personality and emotion. Dr. Skubic's study is not under attack.

Elvera Skubic compared certain emotional reactions of boys in league competition with those of boys competing in physical education classes. Within its stated limitations this was a very worthwhile piece of research and should be followed by others of a similar nature. But many people are referring to it as *proof* that league play is no more emotionally disturbing than class play.

Actually, she did not prove this at all—as, indeed, she took pains to indicate. She merely showed that the one group did not have a significantly greater change in *one* physiological indicator of emotional disturbance—the galvanic skin response—than the other. Other equally respectable physiological indicators could and may very well have shown something quite different. Moreover, the measured emotional arousal may have had entirely different meanings for the two groups, since the galvanic skin response indicates only that there was or was not a change in skin conductivity but gives no hint of the psychological significance lying behind it.

There is also the unexplored consideration that the human organism is better able to tolerate intense emotional upset for a short time than relatively mild upset over a long period of time. Thus, psychosomatic disorders are bodily failures or symptom reactions in the face of prolonged—not short-term—emotional stress.

And finally, it is well known that any emotionally traumatic effects arising from an experience may not manifest for a considerable period of time. In other words, intensity of reaction may not be the critical factor at all.

Emotion study is just getting started in this field. A lot more work will have to be done before we can say much about the effects of sports competition upon the emotions.

—*Warren R. Johnson, University of Maryland.*

Research Abstracts

Council of the Research Section, PAUL A. HUNSICKER, Chairman
Prepared by the Research Abstracts Committee of the National

Education

18. GEORGE, CLAY E. and A. J. KINGSTON. The stability of test scores of college freshmen. *J. Educ. Psych.*, **46**: 4, pp. 243-246 (April 1955).

Entering freshmen of a Southern college were administered the *Occupational Interest Inventory* and a randomly selected group were readministered the inventory. It was found that interest patterns of certain male freshmen had changed radically in less than two months of college work. There were also a very large number of marked individual changes in both profile shape and subtest levels. The instability of the instrument necessitates judicious interpretation.—*D. B. Van Dalen.*

19. GOWAN, J. C., and MAY GOWAN. A teacher prognosis scale for M.M.P.I. *J. Educ. Res.*, **49**: 1 (Sept. 1955).

Designed to predict teaching success, a new scale for the Minnesota Multiphasic Inventory (M.M.P.I.) was devised by means of an item analysis based on four separate criteria. Three groups made up of teaching candidates and one of experienced teachers were used. The reliability of the scale is about .90. Evidence of validity is presented in three studies. Preliminary studies and intercorrelations with other measures of personality suggest the nature of the scale.—*Edna Willis.*

20. JOHNSON, GRANVILLE B., JR. An evaluation instrument for the analysis of teacher effectiveness. *J. Exper. Educ.*, **23**: 1, pp. 331-344 (June 1955).

Thirteen volunteer teachers (9 men and 4 women) served as subjects. It was found that observation appears to be a valuable tool for the estimation of teacher effectiveness and the Projective Technique for the Analysis of Teacher Aptitude predicted the significant aspects of teaching effectiveness. Age was not a significant factor itself but certain residual features were. The Rorschach added little to the accuracy of prediction of teaching success.—*D. B. Van Dalen.*

21. MADDING, ROBERT A., High school athletic administrative problems, *Athletic Journal*, **15**: 30, 32, 64-67 (May 1955).

A questionnaire survey of 150 Wisconsin high schools (92% return) in regard to current athletic administrative problems. Current practices discussed were in the areas of physical examinations, eligibility procedures, contracting for games, contracting for officials, athletic policies and control, athletic contest management, safety and sanitation, equipment, athletic banquets, and athletic awards.—*J. Grove Wolf.*

22. RARICK, LAWRENCE, Maturity indicators and the development of strength and skill. *Education*, **75**: 69-73 (1954).

No single maturity indicator is a valid instrument of the maturity level of a child. While research on the development of certain strengths and skills during adolescence has received attention, only recently have data been accumulated on younger children which offer a basis for interpreting developmental differences. Research evidence is not available on differential acquisition of motor skills. If the developmental needs of chil-

dren in the realm of these skills are to be met, adequate time and competent instruction must be provided during the time these skills are maturing. The author discusses more than a dozen research studies pertinent to this area.—*Psychological Abstracts.*

23. SCHULTZ, RAYMOND E., and MERLE M. OHLSEN. Interest patterns of best and poorest student teachers, *J. Educ. Soc.*, **29**: 108-12 (Nov. 1955).

Student teachers at the University of Illinois were rated by their supervisors, and the best 15% and the poorest 15% (100 in all) were used as subjects for this study. The Strong Vocational Interest Blank was administered to the subjects and the chi-square test used to identify significant differences in responses between the two groups. The best student group showed a strong interest in working with people, selecting occupations involving teaching, and pursuing intellectual interests. The poorest student group tended to avoid occupations related to teaching and considered salary most important in selecting occupations. The sample was considered too small to make a conclusive evaluation of the Strong's ability to predict teaching success.—*Bruce L. Bennett.*

24. SYMONDS, PERCIVAL M. Characteristics of the effective teacher based on pupil evaluations. *J. Exper. Educ.*, **23**: 1, pp. 289-310 (June 1955).

Investigator had pupils react to seven questions on teacher effectiveness. Pupil rankings agreed with each other with correlations ranging from 70's to low 90's. Pupil rankings correlated with principal ratings in the 60's for principal ratings of teacher discipline, in the 70's for teacher relationship with pupils, and in the 40's for teacher ability to secure pupil achievement. The investigator found that superior teachers were well integrated and possessed good personality organization. Superior teachers also were personally secure self-assured, and liked children. Inferior teacher characteristics tended toward the opposite extreme for the above ratings.—*D. B. Van Dalen.*

25. WILLARD, RUTH. A study of the relationship between the valued-behavior of selected teachers and the learning experiences provided in their classrooms. *J. Educ. Res.*, **49**: 1 (Sept. 1955).

The purpose of this study was to determine the relationship between the values teachers had as indicated by their choices of valued courses of classroom action and the types of learning experiences provided under their guidance in the classroom. Fifty-three teachers in elementary schools were the subjects. Some of the tentative conclusions are as follows: valued-behaviors chosen by teachers were related to their choices of classroom activities; teachers selecting all positive-value choices were reported to provide more individual experiences, more patterns of experiences, and a greater percentage of the total experiences than did teachers selecting any other value pattern.— *Edna Willis.*

Health

26. BRING, SHIRLEY VIRGINIA, ET AL. Nutritional status of school children 15 and 16 years of age in three Idaho communities; blood biochemical tests. *J. Nutrition*, **57**: 1 (Sept. 1955).

Biochemical determinations were made on fasting blood samples from 280 school children 15 and 16 years of age reared in three Idaho communities. The adolescents studied in the northern community had mean serum carotene and copper values significantly lower than those studied in the two southwestern communities. The mean values for the girls were significantly higher than for the boys for ascorbic acid, free cholesterol, copper, and sedimentation rate. The mean values for the boys were significantly higher than the girls for alkaline phosphatase, hemoglobin, and packed cell volume. The subjects aged 15 years had serum alkaline phosphatase values significantly higher than

the older children. The blood values of the girls and boys are compared to suggested limits of normal. Highly significant positive correlations were found for both girls and boys between the following comparisons of whole blood and total cholesterol; carotene and ascorbic acid; carotene and free cholesterol; carotene and total cholesterol; free and total riboflavin; free and total cholesterol; copper and sedimentation rate; hemoglobin and packed cell volume. In many of the other comparisons between blood constituents, only the data of the boys showed highly significant correlations.—*Wistar Institute.*

27. NANDA, RAM SARUP. The distribution pattern of dental caries. *Human Biology*, **27**: 3, pp. 211-229 (Sept. 1955).

Clinical examinations were made of the permanent dentition of 140 white females between the ages of 18 and 21 years. This group represented the middle-class population both socially and economically. Data revealed that a tendency toward specific regional distribution of lesions exists. The first molars constituted the bulk of the extracted teeth with manibular first molars more often extracted than maxillary first molars. The origin of proximal dental carries in the distal surface of a second premolar or the mesial surface of a first molar in either arch. The subsequent spread of lesions is determined by individual susceptibility of each tooth and proximal surface, and usually follows a characteristic tautologous pattern. The last proximal surfaces to succumb are, ordinarily, the mesial surfaces of the maxillary first premolar and the mesial surfaces of the mandibular central and lateral incisors. No relationship was found between the length of time a tooth has been in the oral cavity and its susceptibility to dental carries.—*D. B. Van Dalen.*

28. NATIONAL DAIRY COUNCIL. Weight control programs: diet and physical activity. *Dairy Council Digests*, **27**: 2 (Nov. 1955).

Numerous food combinations and restrictions with respect to foods have been recommended in weight reduction and control programs sponsored across the country by business, professional, and lay individuals and groups. So long as such diets provide fewer calories each day than an individual needs, and water is not retained, weight will be lost in proportion to the calorie deficit achieved. However, lack of success with many of these diets makes it obvious that level of calorie intake is only one measure of a satisfactory diet. To be effective on a long-term basis, weight control diets should: (1) permit loss of stored fat, where loss is desirable, without damage to body structures; (2) permit maintenance of desired body weight after loss by simple additions to the reduction diet; (3) serve as a basic pattern of eating which might be followed the rest of an individual's life; (4) be planned to preserve and train the appetite; (5) provide foods acceptable to the individual and with "staying" qualities to prevent hunger; (6) be varied, interesting and not monotonous; (7) permit eating with others as an inoffensive member of the group; and (8) allow pursuit of normal activities without undue fatigue or hunger. The diet which has come closest to meeting these criteria is a basic diet of 90 grams protein, 90 grams of fat, and enough carbohydrate to bring the total energy value of the diet to 1,500 calories per day.

The caloric expenditure of physical activity must not be overlooked in weight control programs for this is the outstanding factor causing variability in the caloric needs of individuals. The truly sedentary person may have a caloric requirement of as little as 1.2 times his basal metabolism. The person doing extremely heavy work may have a caloric requirement of as much as 4 times his basal metabolism.—*Paul Hunsicker.*

29. RATCLIFF, J. D. "Our busy bones," *Today's Health*, **33**: 32-33, 48, 50-51 (Nov. 1955).

Your bones are among the busiest organs in the body. They are thriving manufacturing plants that oerate 24 hours a day making red blood cells. These red cells age slowly during their 100-day lives and each minute about 180 million of them die. It takes six to

eight weeks for the marrow to restore the red blood cells after a pint of blood has been removed from a healthy person, for a transfusion. Bones also have a major responsibility for producing the white blood cells which fight off infection. Bones act as one of the body's storehouses for reserve nourishment. They also act as busy "swap-shops" for minerals, containing nearly all the body's vital calcium and phosphorus. Miracles have been accomplished in the treatment of fractures, curvature of the spine, bone tumors, and the like, with the expectancy of much more to be accomplished in the future.—*J. Grove Wolf.*

30. Soehren, Irene. "Diabetes," *Today's Health*, **33**: 24-29 (Nov. 1955).

Diabetes is on the increase. Every ten minutes someone in the United States becomes a diabetic. A million Americans know they have the disease, and another million have it without knowing it. The usual symptoms are increase in thirst, constant hunger, frequent urination, loss of weight, itching, easy tiring, changes in vision and slow-healing cuts and scratches. Uncontrolled diabetes may lead to eye trouble, kidney disease, arteriosclerosis, and gangrene. Diabetes is not a crippling or disfiguring disease. It is not painful. It is controllable. Successful treatment is dependent on insulin, exercise, and diet.—*J. Grove Wolf.*

Psychology

31. Castaneda, A., and D. Palermo. Psychomotor performance is a function of amount of training and stress. *J. Exp. Psych.*, **50**: 3 (Sept. 1955).

Two groups of 27 subjects were given 25 training trials on a preliminary task; two groups, 50 trials. All four groups were given 50 re-learning trials in which three of the stimulus and response elements had to be repaired while two were left unchanged. One group from each of the two training groups relearned under stress.

"Stress was found to increase significantly the number of errors to the changed S-R pairs, with this increase being more pronounced with increased training on these pairs. A tendency, though unreliable, was found for stress to decrease the number of errors to the unchanged pairs." It was concluded that for prediction regarding the effects of the drive level on performance, it is necessary to know the strength of the specific habits involved and to know whether the dominant habit is correct or incorrect.—*Edna Willis.*

32. Craig, Eugene A. Perceptual-motor task achievement under two conditions of stimulus display, *J. Gen. Psych.* **53**: 281-5 (Oct. 1955).

The purpose of this study was to investigate the maximum rate at which a relatively simple perceptual motor task could be performed and to find performance limits for the task under two conditions of display. The task was to contact a target with a hand-held stylus. In Condition I, all targets were exposed during the trial, and under Condition II each target was only exposed for 2.5 seconds. Results for the eight subjects indicated that two responses a second were accomplished with little error under either condition, but three responses a second was a real achievement limit. Generally higher mean scores were obtained under Condition II which forced the subject to make target reactions within a time limit. Perhaps Condition II stimulated a degree of anxiety in the subjects which improved performance as suggested in the study by Matarazzo, *et al* (same Journal, July 1955).—*Bruce L. Bennett.*

33. Gibson, Eleanor, R. Bergman, and Jean Purdy. The effects of prior training with a scale of distance on absolute and relative judgments of distance over ground. *J. Exp. Psych.*, **50**: 2 (Aug. 1955).

Two experiments were conducted; one to determine the effect of training on absolute judgments of distance, in yards; and the second to determine the effect of training on "relative (nearer-farther)" judgment of distance to variable targets. In the first case, it was found that the subjects who received pre-training are superior to the controls; and,

in the second case, that "sensitivity of the psychophysical relationship is apparently not increased by training, although the yard-responses become more accurately tied to it.—*Edna Willis.*

34. FRENCH, ELIZABETH. Some characteristics of achievement motivation. *J. Exp. Psych.* **50: 4** (Oct. 1955).

An independent measure of motivation and a performance test were given 90 male subjects under three different verbally created conditions of achievement motivation, relaxed, task motivated, and extrinsically motivated.

It was found that (1) an increase in achievement motivation was a function of both previous motivation level and experimental conditions; (2) performance scores were more closely related to motivation scores than to the experimental conditions; (3) performance scores in one situation tended to be most closely related to motivation scores in another when the situations presented similar motivation cues; (4) when affiliation cues were more prominent in the situation than were achievement cues, performance was related to affiliation motivation scores rather than to achievement motivation scores.—*Edna Willis.*

35. HEMPEL, WALTER E., JR., and EDWIN A. FLEISHMAN, A factor analysis of physical proficiency and manipulative skill. *J. of Applied Psychology*, **39:** 1 (Feb. 1955).

A battery of 46 tests was administered to 400 basic trainee airmen. The tests fell into three general categories: (a) 23 gross physical performance tests; (b) 17 manipulative apparatus tests; and (c) 6 printed tests. The tests were scored on a pass-fail basis, the cutoff point being determined from pretest results such that approximately 50% of the subjects would pass the test. The centroid method was used to factor the matrix of tetrachoric correlations. Zimmerman's graphical method was used to rotate orthogonally the axes.

Seventeen factors were extracted, two of which are considered residual factors. One additional factor, classified as a doublet with "questionable psychological significance," was not identified. Fourteen of the factors were identified as: *Aiming, Limb Strength, Gross Body Co-ordination, Equilibrium Balance, Energy Mobilization, Trunk Strength, Reasoning, Leg Suppleness or Flexibility, Arm-Hand Steadiness, Trunk Flexibility, Manual Dexterity, Performance of Dynamic Balance, Finger Dexterity,* and *Jump Performance.* Conclusions claimed that abilities responsible for the performance on the gross physical tests are independent of the abilities responsible for the performance on the manipulative tests. The nine factors of a gross physical nature were categorized into: (a) *strength*—limb and trunk, (b) *flexibility*—legs and trunk, (c) *balance*—static and dynamic, (d) *gross body coordination,* (e) *energy mobilization.* The four manipulative tests (manual dexterity, finger dexterity, arm-hand steadiness, and aiming) have been identified in other studies.—*Frances Z. Cumbee.*

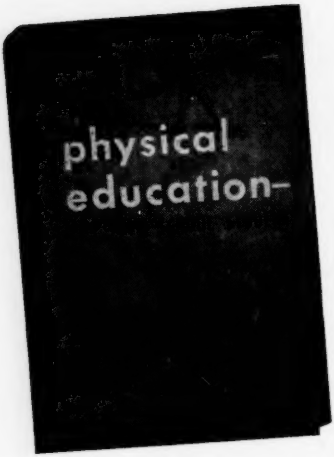
36. HOLLINGSHEAD, A. B. Social mobility and mental illness. *Am. J. Psychiatry*, **112:** 3 (Sept. 1955).

To test the hypothesis that social mobility is related to psychoneuroses and schizophrenia, 25 psychoneurotics, 25 schizophrenics, and 25 control subjects were studied. It was found that the psychoneurotics and schizophrenics are more mobile than the control subjects, and that there is a discrepancy between achieved and aspired mobility in the case of the psychiatric patients.—*Edna Willis.*

37. MATARAZZO, JOSEPH D., GEORGE A. ULETT, and GEORGE SASLOW. Human maze performance as a function of increasing levels of anxiety, *J. Gen. Psych.*, **53:** 79-95 (July 1955).

This study was designed to check the hypothesis that anxiety, as an acquired drive, would facilitate learning up to a point, but beyond this level increased anxiety would

hinder learning. One hundred and one male subjects were given the Taylor Manifest Anxiety Scale and classified into seven groups (later reduced to four) on a scale of increasing anxiety level. Two measures of learning a stylus maze were used: (a) time, and (b) trials to reach a criterion. When time was the measure of learning, a curvilinear relationship was found which supported the hypothesis. The data on trials showed a rectilinear relationship. The authors feel that the Taylor scale is a reliable though crude way of measuring anxiety but that it needs to be validated against psychiatric rating on anxiety.—*Bruce L. Bennett.*



PHYSICAL EDUCATION FOR HIGH SCHOOL STUDENTS

"The publication of this book marks one of our greatest professional achievements."
—Eleanor Metheny

A book of sports, games, athletics, and recreation activities for teen-agers

Clothbound cover—$3.00

416 pages 6" x 9"

Cover in four colors

NEA discount on quantity orders: 2-9 copies, 10%
10 copies or over, 20%

AAHPER Publications-Sales
1201 - 16th St., N.W.
Washington 6, D. C.

CONTENTS

PART I—GETTING STARTED
What Physical Education Can Do for you—Keeping Fit.

PART II—ACTIVITIES
Sports
Angling — Archery — Badminton — Baseball and Softball — Basketball — Bowling — Field Hockey — Golf — Gymnastics and Tumbling — Handball — Lacrosse — Riflery — Soccer — Speedball — Swimming — Tennis — Touch Football — Track and Field — Volleyball — Wrestling.
Dance
Folk Dance — Social Dance — Square Dance — Modern Dance.
Games and Parties
Recreational Games — Co-recreational Parties.

PART III—ATHLETICS
Intramurals — Interscholastics — Keeping in Top Condition.

PART IV—CAREER INFORMATION
Physical Education as a Career — Recreation as a Career.

Companion Volumes

RESEARCH METHODS
(Revised Edition)
585 pp. $5.00

MEASUREMENT AND EVALUATION MATERIALS
138 pp. $2.50

Prepared by the National Research Council
of the Research Section of the AAHPER

MASTERS THESES
1930-46
Over 3,500 titles
cross-indexed under subjects
and areas
292 pp. $3.00

DOCTORATE THESES
1930-46
List of 420 theses
reported by graduate
departments
40 pp. 50c

by Thomas K. Cureton
University of Illinois

Order these professional publications from

AMERICAN ASSOCIATION FOR HEALTH, PHYSICAL EDUCATION, AND RECREATION

1201 Sixteenth St., N.W. Washington 6, D. C.

AAHPER College Conference Reports

Intramural Sports for College Men and Women	*Physical Education for College Men and Women*
November 1955 $1.00	October 1954 $1.00

Professional Pre-Service Preparation of Teachers of Physical Education

1954 $1.00

Health Education for Prospective Teachers: a Guide to Action	*A Forward Look in College Health Education*
January 1956 $1.00	January 1956 $1.00

Report of the Conference on the Undergraduate Physical Education Minor Program and Desirable Professional Education Emphases for the Physical Education Major Program

January 1955 $1.00

Prices

AAHPER, 1201 16TH ST., N.W. WASHINGTON 6, D. C.